

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
 US Department of Commerce
 United States Patent and Trademark
 Office, PCT
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 CP2/5C24
 Arlington, VA 22202
 ETATS-UNIS D'AMERIQUE
 in its capacity as elected Office

Date of mailing (day/month/year) 27 November 2000 (27.11.00)	
International application No. PCT/FI00/00278	Applicant's or agent's file reference 49538
International filing date (day/month/year) 31 March 2000 (31.03.00)	Priority date (day/month/year) 01 April 1999 (01.04.99)
Applicant RAMM-SCHMIDT, Leif et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:
 25 October 2000 (25.10.00)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer F. Baechler
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

PATENTTIHAKEMUS NRO 990735 <i>Application no.</i>	LUOKITUS <i>Classification</i> B 01D 1/22
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TUTKITTU AINEISTO <i>Material Searched</i>
Patenttijulkaisukokoelma (FI, SE, NO, DK, DE, CH, EP, WO, GB, US), tutkitut luokat <i>Collection of patent publications (FI, SE, NO, DK, DE, CH, EP, WO, GB, US), classes searched</i>
Tiedonhaut ja muu aineisto <i>Information retrievals and other material</i> Epoque (epodoc, wpi, paj)

VIITEJULKAISUT <i>Used references</i>		
Kategoria*) <i>Category</i>	Julkaisun tunnistetiedot <i>Identification data of the publication</i>	Koskee vaatimuksia <i>Relevant to claims</i>
<p>*) X Patentoitavuuden kannalta merkittävä julkaisu yksinään tarkasteltuna Y Patentoitavuuden kannalta merkittävä julkaisu, kun otetaan huomioon tämä ja yksi tai useampi samaan kategoriaan kuuluva julkaisu A Yleistä tekniikan tasoa edustava julkaisu, ei kuitenkaan patentoitavuuden este</p>		
Päiväys <i>Date</i> 17.8.99	Tutkija <i>Examiner</i> Timo Maunola	

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PCT REQUEST

49538

Original (for **SUBMISSION**) - printed on 31.03.2000 08:14:27 AM

0	For receiving Office use only	
0-1	International Application No.	PCT/FI 0 0 / 0 0 2 7 8
0-2	International Filing Date	3 1 MAR 2000 (3 1. 03. 00)
0-3	Name of receiving Office and "PCT International Application"	The Finnish Patent Office PCT International Application
0-4	Form - PCT/RO/101 PCT Request	
0-4-1	Prepared using	PCT-EASY Version 2.90 (updated 08.03.2000)
0-5	Petition The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	Receiving Office (specified by the applicant)	National Board of Patents and Registration (Finland) (RO/FI)
0-7	Applicant's or agent's file reference	49538
I	Title of invention	A PROCESS FOR EVAPORATING A SOLUTION AND AN EVAPORATOR FOR USE IN THE PROCESS
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V	Designation of States	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AP: GH GM KE LS MW SD SL SZ TZ UG ZW and any other State which is a Contracting State of the Harare Protocol and of the PCT EA: AM AZ BY KG KZ MD RU TJ TM and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT EP: AT BE CH&LI CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE and any other State which is a Contracting State of the European Patent Convention and of the PCT OA: BF BJ CF CG CI CM GA GN GW ML MR NE SN TD TG and any other State which is a member State of OAPI and a Contracting State of the PCT

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V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AE AG AL AM AT AU AZ BA BB BG BR BY CA CH&LI CN CR CU CZ DE DK DM DZ EE ES FI GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MA MD MG MK MN MW MX NO NZ PL PT RO RU SD SE SG SI SK SL TJ TM TR TT TZ UA UG US UZ VN YU ZA ZW	
V-5	Precautionary Designation Statement In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.		
V-6	Exclusion(s) from precautionary designations	NONE	
VI-1	Priority claim of earlier national application		
VI-1-1	Filing date	01 April 1999 (01.04.1999)	
VI-1-2	Number	990735	
VI-1-3	Country	FI	
VI-2	Priority document request The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1	
VII-1	International Searching Authority Chosen	Swedish Patent Office (ISA/SE)	
VIII	Check list	number of sheets	electronic file(s) attached
VIII-1	Request	4	-
VIII-2	Description	7	-
VIII-3	Claims	3	-
VIII-4	Abstract	1	49538.txt
VIII-5	Drawings	4	-
VIII-7	TOTAL	19	
	Accompanying items	paper document(s) attached	electronic file(s) attached
VIII-8	Fee calculation sheet	✓	-
VIII-9	Separate signed power of attorney	✓	-
VIII-16	PCT-EASY diskette	-	diskette
VIII-17	Other (specified):	Copy of Official Action in FI 990735	-
VIII-18	Figure of the drawings which should accompany the abstract	1	
VIII-19	Language of filing of the international application	Finnish	

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IX-1	Signature of applicant or agent	
IX-1-1	Name	BERGGREN OY AB
IX-1-2	Name of signatory	Olli-Pekka Saijonmaa
IX-1-3	Capacity	Patent Agent

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10-1	Date of actual receipt of the purported international application	31 MAR 2000 (31-03-2000)
10-2	Drawings:	
10-2-1	Received	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/SE
10-6	Transmittal of search copy delayed until search fee is paid	

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11-1	Date of receipt of the record copy by the International Bureau	01 MAY 2000 (01.05.00)
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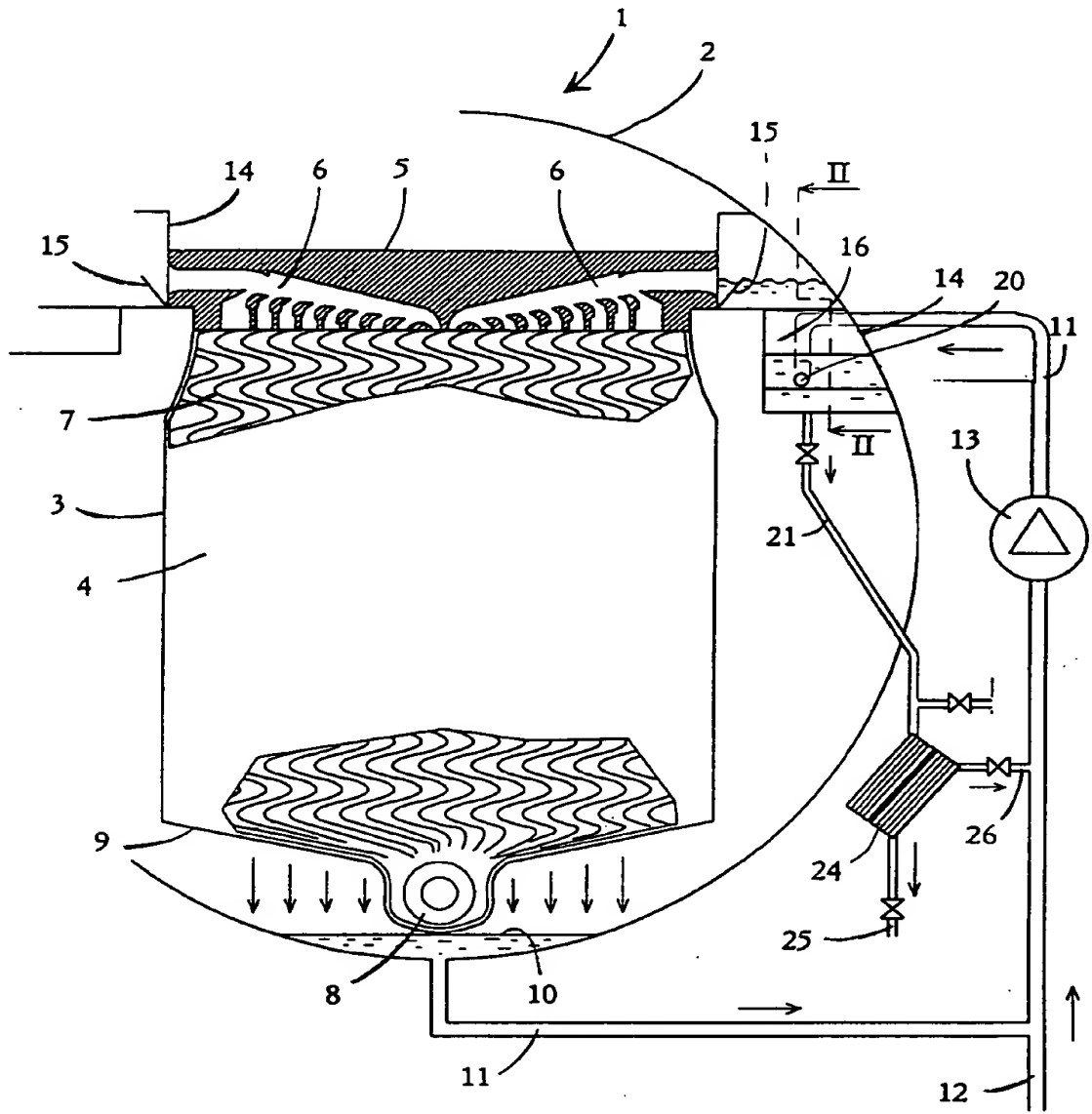


Fig. 1

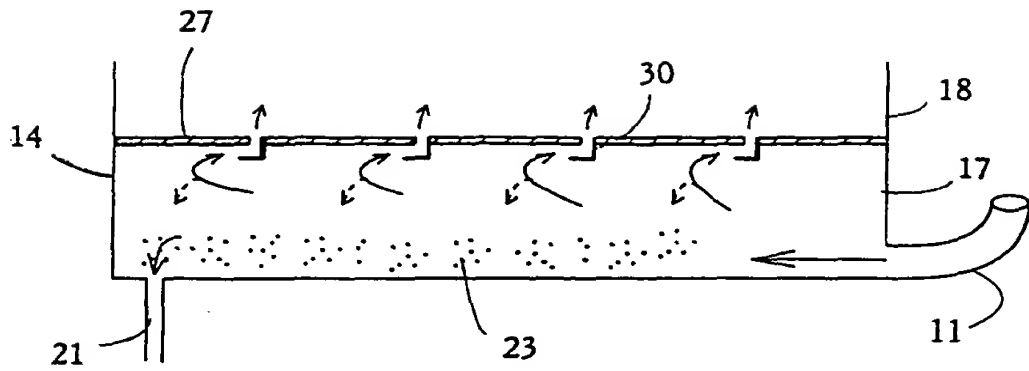


Fig. 5

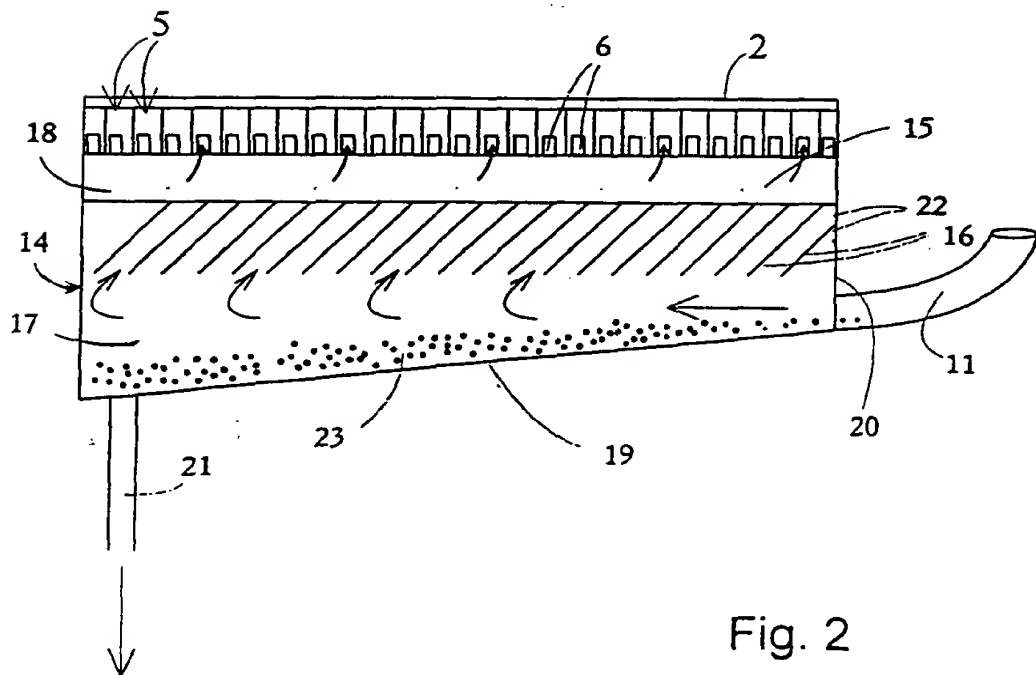


Fig. 2

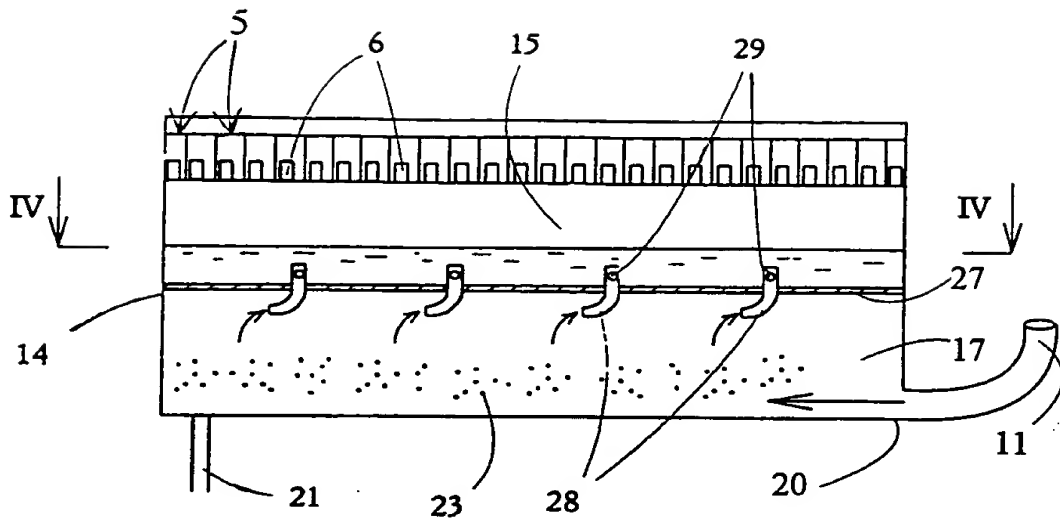


Fig. 3

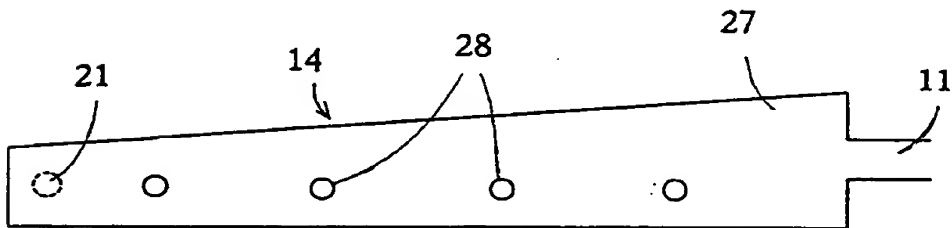


Fig. 4

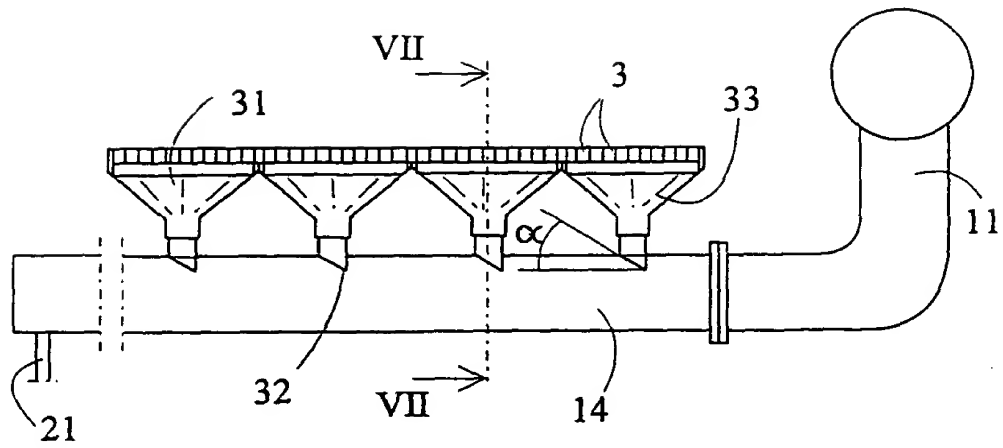


Fig. 6

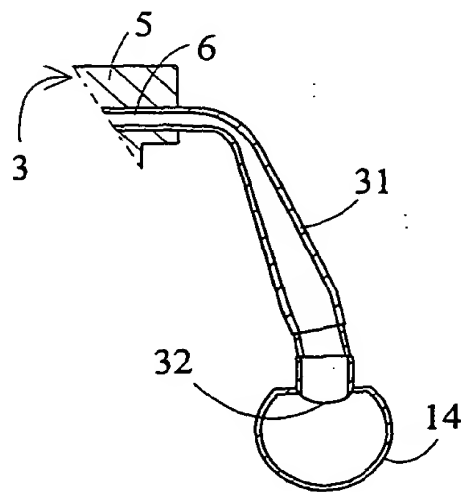


Fig. 7

Menetelmä liuoksen haihduttamiseksi sekä menetelmässä käytettävä haihdutin

Tämän keksinnön kohteena on menetelmä liuoksen haihduttamiseksi, jossa liuos levitetään haihduttimen rinnakkaisten, levymäisten lämmönvaihdinelementtien lämmönsiirtopinnoille valumaan niillä ylhäältä alaspäin, liuoksen syötön tapahtuessa elementeille yhteisestä nestejakotilasta, lämmönsiirtopinnoilla haihtumatta jäänyt liuos ja haihdutuksen yhteydessä muodostunut sakka poistetaan haihduttimen alapäästä ja haihtumatta jäänyt liuos kierrätetään takaisin lämmönsiirtopinnoille niillä tapahtuvaa uutta haihdutusta varten. Lisäksi keksintö kohdistuu mainitussa menetelmässä käytettävään haihduttimeen.

FI-julkaisuissa 79948 ja 86961 on kuvattu kalvomateriaalia, kuten muovia, olevista pussimaisista lämmönsiirtoelementeistä muodostuvia lämmönvaihtimia, jotka soveltuvat mm. tislaukseen sekä erilaisten suspensioiden väkeväintiin. Elementit ovat lämmönvaihtimessa sidottuina toisiaan vasten pakaksi, jossa vesi johdetaan haihtumaan elementtien ulkopinnoille, minkä jälkeen haihdehöyry puristetaan kompressorilla korkeampaan paineeseen ja lämpötilaan ja johdetaan elementtien sisään lämmityshöyryksi, joka lämmönsiirrossa lauhtuu takaisin vedeksi.

Haihduttamalla tapahtuvassa liuosten väkevöinnissä liuenneiden komponenttien kylästysaste kasvaa, ja kylästyspisteen ylittyessä seurauksena on saostuminen. Esimerkkeinä voidaan mainita sellun valkaisu-jätevesistä saostuva kalsiumoksalaatti, pohjavesistä saostuvat kalsiumkarbonaatti, -sulfaatti ja -silikaatti sekä mahdolliset rautayhdisteet, elintarviketeollisuuden jätevesistä saostuvat denaturoituneet proteiinit sekä mineraalipitoisista jätevesistä saostuvat suolat, kuten kipsi ja rautasuolat tai hydroksidit. Mainittujen julkaisujen mukaisissa lämmönvaihtimissa kalvopinnoilla syntyvä sakka, kuten myös käsiteltävien suspensioiden sisältämät kiintoainekset, kerääntyvät helposti pussimaisten elementtien välissä kakuksi, joka haittaa lämmönsiirtoa sekä neste- ja höyryvirtauksia ja jonka takia elementtien välejä voidaan aika ajoin joutua puhdistamaan. FI-hakemuksessa 970273 on kuitenkin esitetty haihdutin, jossa elementtien muotoa on parannettu niin, että sakka tai muu kiintoaines putoaa haihdutuksen aikana elementtien väleistä haihduttimen pohjalle, eli haihdutin on elementtien osalta itsepuhdistuva.

Haihduttimissa, joissa käsiteltävän liuoksen tai suspension haihtumatta jäänyt osa kierrätetään takaisin lämmönsiirtopinnoille riittävän haihdutusasteen saavuttamiseksi, jää kuitenkin ongelmaksi se, että elementtien välistä haihduttimen pohjalle

- pudonnut kiintoaines joutuu mukaan nestekierto, jolloin se voi tukkia elementtien yläpäiden kapeita nesteenjakokanavia, joista neste syötetään elementtien pinnoille. Koska haihdutuksen tehokkuus riippuu ratkaisevasti nesteen tasaisesta leviämisestä elementtien lämmönsiirtopinnoille, on sakan ja muun kiintoaineksen poistaminen
- 5 kiertovirtauksesta välttämätöntä syöttökanavien tukkeutumisen estämiseksi.

- Tukkeutumisongelmaa voitaisiin helpottaa yksinkertaisella tavalla varustamalla kiertolinja erotuslaitteella, kuten suodattimella, syklonalla tai sedimentaattorilla, joka erottaisi sakan nesteestä ennen viimeksi mainittua kierrätystä takaisin haihdutusvaiheeseen. Tällainen ratkaisu olisi kuitenkin tilankäytön ja kustannusten kannalta
- 10 epäedullinen, minkä lisäksi erottimen aiheuttama painehäviö lisää pumppaukseen tarvittavaa energian käyttöä. Mikäli erotin on sijoitettu kiertopumpun imupuolella, voi painehäviö aiheuttaa pumpun kavitointia. Lisäksi ongelmaksi jäisivät edelleen erottimen jälkeisen kierrätysputkiston seinämistä irtoavat kiintoainekset, jotka päätyisivät elementtien nesteenjakokanaviin.

- 15 Edellä mainittujen haittojen välttämiseksi sakan tms. kiintoaineksen erotus uuteen haihdutukseen kierrätettävästä liuksesta on keksinnön mukaan järjestetty tapahtumaan samassa yhteydessä, kun neste jaetaan haihduttimen eri elementtien lämmönsiirtopinnoille johtaviin syöttövirtauksiin. Keksinnön mukaiselle menetelmälle on tunnusomaista se, että kierrätettävä liuos syötetään nesteenjakotilaan niin, että liukosen mukana oleva sakka erottuu tilassa painonsa ja/tai liike-energiansa vaikutuksesta
- 20 samalla kun liuksen virtaus suuntautuu ylöspäin, että sakka poistetaan tilan pohjasta alkavaan poistojohtoon ja että liuos ohjataan tilasta elementtien lämmönsiirtopinnoille johtaviin syöttöyhteisiin.

- Keksinnön mukaisen haihduttimen, jolla edellä kuvattu haihdutusmenetelmä on toteutettavissa, oleellisten tunnusmerkkien osalta viitataan oheisiin patenttivaatimukseen, erityisesti vaatimukseen 7.
- 25

- Keksintö soveltuu etenkin kalvohaihduttimiin, joissa pussimaiset lämmönvaihdin-elementit muodostuvat taipuisasta kalvomateriaalista, kuten muovikalvosta. Näissä sakkaa voi irrota lämmönsiirtopinnoilta paitsi pesun yhteydessä myös ajon aikana, eli ne voivat olla itsepuhdistuvia, jolloin irronneen sakan poistaminen liuoskierrosta on välttämätöntä.
- 30

Keksinnön mukaisella sakan erotuksen kytkemisellä lämmönsiirtopinnoille menevän liuksen syöttöön saavutetaan se, että paitsi lämmönsiirtopinnoilta myös kierrätysputkistoista peräisin olevat kiintoainekset saadaan poistetuksi liuksesta juuri ennen

tukkeutumisen kannalta kriittisintä syöttövaihetta. Näin järjestetty sakanerotus ei ole myöskään häiritsemässä haihduttimen pesua, jossa suuria määriä irtoavaa sakkaa joutuu pesuvesiin, jotka poistetaan haihduttimen pohjalta. Tilankäytön kannalta ja toiminnallisesti edullisinta on, jos nesteenjaketila sijaitsee haihduttimen vaipan sisä-
5 puolella.

Nesteenjaketila voi edullisesti olla muotoiltu pitkänomaiseksi putkeksi, jonka toinen pää on yhteydessä liuoksen kierrätysjohtoon ja vastakkainen pää on varustettu sakan poistojohdolla. Lämmönsiirtopinnoille johtavat syöttöyhteet ovat tässä ratkaisussa edullisesti nesteenjaketilasta alkavia, viuhkamaisesti laajenevia jakosuulakkeita,
10 joista kukin syöttää liuosta useampaan rinnakkaiseen, lämmönvaihdinelementtien lämmönsiirtopintojen väliseen rakoon, joissa haihtuminen tapahtuu. Ennen yhtymistään nesteenjaketilaan kierrätysjohto muodostaa edullisesti ylhäältä alaspäin tilaa kohti suunnatun kaaren, jolloin keskipakovoima saadaan painamaan sakkaa johdon kehälle ja sen jatkeena olevalle nesteenjaketilan pohjalle jo liuoksen tulovaiheessa.
15 Sakka kulkeutuu sitten tilasta pohjavirtauksena lyhintä tietä poistojohdoon.

Vaihtoehtoisesti nesteenjaketila voi muodostua pitkänomaisesta kaukalosta, joka voidaan varustaa rinnakkaisilla, viistoilla lamelleilla, joiden alapuolelle kierrätettävä liuos syötetään ja joiden välitse liuos pääsee virtaamaan ylöspäin. Liuoksen virtaus kiertyy tällöin lamellien välisiin, ylöspäin suuntautuviin virtauskanaviin samalla,
20 kun sakka erottuu virtauksesta keskipakovoiman vaikutuksesta. Tämä sakan liike-energiaan perustuva erotus on tehokasta varsinkin silloin, kun lamellit ovat kallistettuina vastavirtaan kierrätysvirtauksen tulosuuntaan nähden. Mainittu liuoksen kierrätysjohdon kaarevuus on eduksi myös tässä sovellutuksessa.

Sakkapartikkelien liike-energian ohella tai asemesta sakan erotuksessa voidaan hyödyntää painovoimaa järjestämällä nesteenjaketilaan laminaarit virtausolosuhteet siten, että tila siihen järjestettyine viistoine lamelleineen toimii lamelliselkeyttimenä. Partikkelien sedimentoitumista edesauttaa myös se, jos nesteenjaketilan pohja on kierrätysvirtauksen tulosuunnassa viistosti alaspäin viettävä.
25

Nesteenjaketila tai sen alaosa on edelleen edullista muotoilla siten, että se suppenee kierrätysvirtauksen tulosuunnassa kiilamaisesti tai kartiomaisesti kohti tilan kierrätysjohtoon nähden vastakkaiselta puolelta alkavaa poistojohdtoa. Nestevirtauksen nopeus voidaan tällöin pitää oleellisesti vakiona siten, että tilassa aikaansaadaan tasainen ylöspäin suuntautuva virtaus ja nesteen tasainen jako eri lämmönsiirtoelementtien syöttöyhteisiin.
30

Mainittujen viistojen lamellien asemesta kaukalomainen nesteenjako-tila voidaan varustaa sen alempaan ja ylempaan osaan jakavalla välipohjalla, jossa on tarvittavat virtausaukot ylöspäin suunnattua nestevirtausta varten. Aukot voivat olla viistoja ja niitä rajaavat seinämät enemmän tai vähemmän lamellimaisia sakan erottumisen tehostamiseksi, tai välipohjassa voi olla virtauksen läpäiseviä erotin-elimisiä, kuten sykloneja tai viistoja tai käyristettyjä putkia, jotka toimivat virtauskanavina.

Nesteenjako-tilasta poistojohtoon erottuva sakka voidaan johtaa selkeyttimeen, jossa sakka erotetaan sen mukana tulleesta nesteestä, jonka määrä on yleensä n. 3-50 %, edullisesti 3-25 %, haihduttimessa kierrätetyn virtauksen kokonaismäärästä, minkä jälkeen neste voidaan palauttaa kierrätysvirtaukseen.

Keksintöä selostetaan seuraavassa yksityiskohtaisemmin esimerkkien avulla viittaamalla oikeisiin piirustuksiin, joissa

- 15 kuvio 1 esittää poikkileikkauksena erästä keksinnön mukaista haihdutinta kalvo-materiaalia olevine lämmönsiirtoelementteineen ja nesteenkierrätyskanavistoineen, joihin on järjestetty kiintoaineksen erotus,
- kuvio 2 esittää haihduttimen nesteenjako-kaukaloa leikkauksena II-II kuviosta 1,
- kuvio 3 esittää kuviota 2 vastaavasti nesteenjako-kaukaloa keksinnön erään toisen sovellutusmuodon mukaisena,
- kuvio 4 on vaakaleikkaus IV-IV kuviosta 3,
- 20 kuvio 5 esittää nesteenjako-kaukalon alaosa ja välipohjaa sakanerotuselimineen keksinnön erään kolmannen sovellutusmuodon mukaisesti,
- kuvio 6 esittää erästä keksinnön viidettä sovellutusmuotoa, jossa putkimaiseen nesteenjako-tilaan on kytketty rinnakkaisia jakosuulakkeita nesteen syöttämiseksi elementtien lämmönsiirtopinnoille, ja
- 25 kuvio 7 on leikkaus VII-VII kuvion 6 mukaisesta putkesta ja jakosuulakkeesta.

Kuvion 1 mukainen haihdutin 1 käsittää lieriömäisen vaipan 2 sekä sen sisään sovitettuja rinnakkaisia, muovikalvoa olevia pussimaisia lämmönsiirtoelementtejä 3. Elementit 3 ovat haihduttimessa sidottuina pakaksi, joka voi koostua useista kymmenistä elementeistä. Elementtien ulkopinnoilla 4 eli toisiaan vasten sijaitsevien elementtien väleissä tapahtuu käsiteltävän liuoksen haihdutus lämmöllä, joka saadaan samanaikaisesti elementtien sisällä lauhtuvasta höyrystä. Lämmityshöyrynä

voidaan käyttää haihdutuksessa syntyvää höyryä, joka kierrätetään kompressorin kautta elementtien sisään johtaviin höyrynsyöttökanaviin (ei esitetty).

Kunkin pussimaisen lämmönsiirtoelementin 3 yläpäässä on sopivasti muovista valettu lista 5, joka sisältää kanavistot 6 haihdutettavan nesteen syöttämiseksi elementtien välisille kalvopinnoille valumaan niillä ylhäältä alaspäin. Elementin 3 sisus on jaettu pystysuuntaisin, mutkittelevin saumoin 7 kanaviin, jotka ohjaavat lämmityshöyryn ja siitä syntyvän lauhteen virtausta kohti elementin alapäässä sijaitsevaa, elementin sisäpuolelle saumattua kiekkomaisista lauhteenpoistoelintä 8. Vierekkäisten elementtien 3 pohjat 9 jäävät lauhteenpoistoelinten 8 molemmin puolin riittävästi irralliseen toisistaan päästääkseen haihdutuksen yhteydessä elementtien väleissä muodostuneen sakan tai haihdutettavan liuoksen mukana tulleen muun kiintoaineksen putoamaan haihduttimen pohjalle, johon myös haihtumatta jäänyt liuos 10 kerääntyy.

Koska kullakin haihdutuskerralla ainoastaan pieni osa haihdutettavasta liuoksesta muuttuu höyryksi, käsittää haihdutin 1 laitteet, joilla haihtumatta jäänyt liuos voidaan toistuvasti kierrättää takaisin elementtien kalvopinnoille 4 uutta haihdutusta varten. Ko. laitteet muodostuvat haihduttimen pohjalta alkavasta kierrätysjohdosta 11, johon yhtyy johto 12, josta uutta haihdutettavaa liuosta tuodaan haihdutusprosessiin, pumpusta 13, haihduttimen vaipan 2 sisäpuolisesta nesteenjakokaukalosta 14, kaukalo on sijoitetusta, ylivuotokynnyksenä toimivasta patolevystä 15 sekä jo mainituista elementtien yläpäiden nesteensyöttökanavistoista 6. Nesteenjakokaukalon 14 tehtävänä on haihdutukseen syötettävän liuoksen mahdollisimman tasainen jakaminen eri elementteihin 3 kuuluvien kanavistojen 6 kesken. Liuoksen syöttö elementtien kalvopinnoille 4 tapahtuu symmetrisesti elementtien kummallakin sivulla olevista nesteenjakokaukaloista 14, joista kuitenkin ainoastaan toinen on esitetty yksityiskohtaisesti kuviossa 1.

Nesteenjakokaukalon 14, joka keksinnön mukaan toimii myös kierrätetyn liuoksen mukana olevan sakan tms. kiintoaineksen erottimena, rakenne selviää parhaiten kuviossa 2. Kaukalo 14 on varustettu joukolla rinnakkaisia, viistoja lamelleja 16, jotka jakavat kaukalon alempaan ja ylempään osaan 17, 18. Kuvion mukaisesti alaspäin kaareva liuoksen tulojohto 11 liittyy kaukalon alempaan osaan 17, jonka pohja 19 viettää viistosti kohti kaukalon kierrätysjohdon suuhun 20 nähden vastakkaiselta puolelta alkavaa sakan poistojohtoa 21. Rinnakkaiset lamellit 16 on kallistettu liuoksen tulosuuntaa vastaan niin, että virtauksen on kiertyttävä kuviossa 2 olevien nuolten mukaisesti yli 90° päästäkseen lamellien välisiin, viistosti ylöspäin suuntautuviin virtauskanaviin 22. Näissä olosuhteissa aikaansaadaan liuoksen mukana tulevan

- kiintoaineksen 23 erottuminen osaksi oman liike-energiansa, so. keskipakovoiman, ja osaksi painovoiman vaikutuksesta nestevirtauksesta ja sedimentoituminen kohti kaukalon pohjasta alkavaa poistojohtoa 21. Virtausnopeutta säätämällä virtaus pidetään kaukalon alaosassa 17 ja lamellien 16 väleissä laminaarina ja riittävän hitaana, jolloin selkeyttimen tavoin toimivat lamellit 16 viime kädessä estävät kiintoainesta pääsemästä ainakaan haitallisessa määrin kaukalon ylempään osaan 18. Kaukalon yläosassa patolevy 15 muuttaa syöttökanaviin 6 menevän nestevirtauksen turbulenssiksi, millä edelleen vähennetään tukkeutumien riskiä kapeissa, lukuisiin haaroihin jakautuvissa syöttökanavistoissa 6 (vrt. kuvio 1).
- 10 Nesteenjakoaukalosta 14 poistetaan johtoon 21 sakan ohella nestettä, jonka määrä voi vaihdella välillä 3-50 % kierrätysjohtoa 11 myöten kaukaloontulevasta virtauksesta. Sakan lopullinen erotus kiintoaineksesta tapahtuu kuvion 1 mukaan lamelliselkeyttimessä 24, josta sakka poistetaan johtoon 25 ja neste palautetaan johdon 26 kautta kiertovirtaukseen pumpun 13 imupuolelle. Sakan poisto voidaan suorittaa aika ajoin suoritettulla huuhtelulla johtojen 21 ja 26 venttiilien ollessa suljettuina.
- 20 Kuvioissa 3 ja 4 on esitetty haihduttimen nesteenjakoaukalo 14, joka eroaa kuviossa 2 esitetystä siinä, että kaukalo on tasapohjainen, mutta kiilamaisesti kierrätysjohdon suulta 20 kaukalon vastakkaista sivua kohti kapeneva ja että kaukalossa on viistojen lamellien asemesta välipohja 27, jossa on sakanerottimina toimivia, nesteen läpivirtauksen sallivia käyristettyjä putkikappaleita 28. Painovoima sekä kaarevassa tulojohdossa 11 vaikuttava keskipakovoima painavat sakkaa kohti kaaren ulkokehää ja kaukalon 14 pohjaa siten, että pääosa sakasta kulkeutuu liike-energiansa vaikutuksesta suoraan poistojohtoon 21. Nestevirtaus ohjautuu mainittuihin sakanerottimiin, joissa painovoima erottaa virtauksessa jäljellä olevaa sakkaa, nestevirtauksen jatkaessa erottimien yläpäissä olevista sivuttaisista aukoista 29 nesteenjakoaukalon 14 ylempään osaan 18. Kaukalon 14 kapenevalla muodolla on aikaansaatu se, että virtausnopeus on kaikissa putkikappaleissa 28 oleellisesti sama.
- 30 Kuviossa 5 esitetyssä nesteenjakoaukalon 14 sovellutuksessa kuvion 3 mukaiset käyristetyn putkikappaleen 28 on korvattu välipohjassa 27 läpivirtausaukkoja reunustavilla L-muotoisilla ulokkeilla 30. Muutoin kuvion 5 sovellutus vastaa edellä esitettyä.
- 35 Kuvioissa 6 ja 7 on esitetty keksinnön sovellutus, jossa nesteenjakoaukalo 14 muodostaa poikkileikkaukseltaan oleellisesti pyöreä putki, joka on nesteen tulojohdon 11 jatkeena. Putki 11 muodostaa kuvion 7 mukaisesti kaaren, jossa vaikuttava keskipakovoima painaa nesteen sisältämää kiintoainesta kaaren ulkokehälle ja edelleen

5 nesteenjakotilan 14 pohjalle, josta kiintoaines päätyy poistojohtoon 21. Nesteenjakotilaan 14 on liitetty rinnakkaisia jakosuulakkeita 31, jotka jakavat pääosin kiintoaineksesta puhdistuneen nesteen rinnakkaisten lämmönsiirtoelementtien 3 päätyli-
tojen 5 sisältämiin nestekanaviin 6. Nesteenjakotilan 14 sisään ulottuvat jakosuulak-
keiden 31 kärjet 32 on viistetty kulmaan α , joka on sopivasti noin $10-35^\circ$, ja suulak-
keet ovat muodoltaan viuhkamaisesti laajenevia niin, että kukin niistä syöttää nestet-
tä useisiin vierekkäisiin elementteihin 3. Jakosuulakkeet 31 on edelleen varustettu
sisäpuolisilla väliseinillä 33 nesteen tasaisen jakautumisen varmistamiseksi.

10 Alan ammattimiehelle on selvää, että keksinnön erilaiset sovellutusmuodot eivät rajoitu edellä esimerkkeinä esitettyyn vaan voivat vaihdella seuraavien patenttivaatimusten puitteissa. Keksinnön mukaista sakanerotusta voidaan siten soveltaa paitsi edellä kuvatuissa kalvohaihduttimissa myös perinteisissä metallisia lämmönsiirtoelementtejä käsittävissä haihduttimissa.

Patenttivaatimukset

1. Menetelmä liuoksen haihduttamiseksi, jossa liuos levitetään haihduttimen (1) rinnakkaisten, levymäisten lämmönvaihdinelementtien (3) lämmönsiirtopinnoille (4) valumaan niillä ylhäältä alaspäin, liuoksen syötön tapahtuessa elementeille yhteises-
5 tä nestejakotilasta (14), lämmönsiirtopinnoilla haihtumatta jäänyt liuos (10) ja haihdutuksen yhteydessä muodostunut sakka poistetaan haihduttimen alapäästä ja haihtumatta jäänyt liuos kierrätetään takaisin lämmönsiirtopinnoille niillä tapahtu-
vaa uutta haihdutusta varten, **tunnettu** siitä, että kierrätettävä liuos syötetään nes-
teenjakotilaan (14) niin, että liuoksen mukana oleva sakka (23) erottuu tilassa pai-
10 nonsa ja/tai liike-energiansa vaikutuksesta samalla kun liuoksen virtaus suuntautuu ylöspäin, että sakka poistetaan tilan pohjasta alkavaan poistojohtoon (21) ja että liuos ohjataan tilasta elementtien lämmönsiirtopinnoille (4) johtaviin syöttöyhteisiin (6, 31).
2. Patenttivaatimuksen 1 mukainen menetelmä, **tunnettu** siitä, että kierrätettävä
15 liuos syötetään nestejakotilaan (14) ylhäältä alaspäin kohti tilan sivua tai päätyä kaartuvana virtauksena (11).
3. Patenttivaatimuksen 1 tai 2 mukainen menetelmä, **tunnettu** siitä, että kierrätet-
tävä liuos syötetään kapeaan, pitkänomaiseen nestejakotilaan (14) sen toisesta
päästä ja että sakka poistetaan poistojohtoon (21) tilan vastakkaisesta päästä.
- 20 4. Jonkin edellisen patenttivaatimuksen mukainen menetelmä, **tunnettu** siitä, että kierrätettävä liuos syötetään nestejakotilassa (14) olevien rinnakkaisten lamellien (16) tai virtausaukoilla (28-30) varustetun välipohjan (27) alapuolelle, jolloin liuok-
sen virtaus kiertyy kohti välipohjan virtausaukkoja tai lamellien välisiä virtauskana-
via (22) sakan (23) erottuessa virtauksesta keskipakovoiman vaikutuksesta.
- 25 5. Jonkin edellisen patenttivaatimuksen mukainen menetelmä, **tunnettu** siitä, että sakka johdetaan poistojohtoa (21) myöten selkeyttimeen (25), jossa sakka erotetaan sen mukana olevasta nestefaasista, minkä jälkeen nestefaasi yhdistetään haihdutti-
messä tapahtuvaan liuoksen kierrätysvirtaukseen.
6. Jonkin edellisen patenttivaatimuksen mukainen menetelmä, **tunnettu** siitä, että
30 haihdutin on taipuisaa kalvomateriaalia, kuten muovikalvoa, olevista lämmönvaihdinelementeistä (3) muodostuva kalvohaihdutin.
7. Haihdutin (1), joka käsittää vaipan (2), vaipan sisään sovitettuja rinnakkaisia levymäisiä lämmönvaihdinelementtejä (3), joiden lämmönsiirtopinnoilla (4) haihdu-

- tettava liuos on järjestetty valumaan ylhäältä alaspäin, nesteenjako-tilan (14), josta haihdutettava liuos on syöttöyhteiden (6, 31) kautta levitettävissä rinnakkaisille läm-
mönsiirtopinnoille niiden yläpäissä, elimet haihtumatta jääneen liuoksen (10) ja
haihdutuksen yhteydessä muodostuneen sakan poistamiseksi haihduttimen alapäästä
5 sekä johdon (11) haihtumatta jääneen liuoksen kierrättämiseksi takaisin elementtien
lämmönsiirtopinnoille niillä tapahtuvaa uutta haihdutusta varten, **tunnettu** siitä, että
nesteenjako-tila (14) on muodostettu lisäksi sakanerottimeksi järjestämällä kierrätys-
johto (11) syöttämään liuoksen tilaan sen sivulta tai päädystä ja varustamalla tila sen
pohjasta alkavalla poistojohdolla (21), jolloin kierrätysvirtauksessa oleva sakka (23)
10 erottuu nesteenjako-tilassa painonsa ja/tai liike-energiansa vaikutuksesta päätyen
poistojohtoon samalla kun kierrätetyn liuoksen virtaus suuntautuu ylöspäin kohti
elementtien (3) lämmönsiirtopinnoille (4) johtavia syöttöyhteitä (6, 31).
8. Patenttivaatimuksen 7 mukainen haihdutin, **tunnettu** siitä, että se on taipuisaa
kalvomateriaalia, kuten muovikalvoa, olevista lämmönvaihdonelementeistä (3) muo-
15 dostuva kalvohaihdutin.
9. Patenttivaatimuksen 7 tai 8 mukainen haihdutin, **tunnettu** siitä, että neste-
jako-tila (14) sijaitsee haihduttimen vaipan (2) sisäpuolella.
10. Jonkin patenttivaatimuksen 7-9 mukainen haihdutin, **tunnettu** siitä, että kierrä-
tysjohto (11) liittyy pitkänomaisen nesteenjako-tilan (14) toiseen päähän ja että sakan
20 poistojohto (21) alkaa nesteenjako-tilan vastakkaisesta päästä.
11. Jonkin patenttivaatimuksen 7-10 mukainen haihdutin, **tunnettu** siitä, että kier-
rätysjohto (11) liittyy ylhäältä alaspäin kaartuen nesteenjako-tilaan (14).
12. Jonkin patenttivaatimuksen 7-11 mukainen haihdutin, **tunnettu** siitä, että nes-
teenjako-tilan (14) pohja on viistosti alaspäin poistojohtoa (21) kohti viettävä.
- 25 13. Jonkin patenttivaatimuksen 7-12 mukainen haihdutin, **tunnettu** siitä, että nes-
teenjako-tila (14) on kiilamaisesti tai kartiomaisesti poistojohtoa (21) kohti suppene-
va.
14. Jonkin patenttivaatimuksen 7-13 mukainen haihdutin, **tunnettu** siitä, että syöt-
töyhteet käsittävät nesteenjako-tilasta (14) alkavia, viuhkamaisesti laajenevia jako-
30 suulakkeita (31), joista kukin syöttää liuosta useampaan rinnakkaiseen, lämmön-
vaihdonelementtien (3) lämmönsiirtopintojen (4) väliseen rakoon, joissa haihtuminen
tapahtuu.

15. Jonkin patenttivaatimuksista 7-14 mukainen haihdutin, **tunnettu** siitä, että kaukalomainen nesteenjako-tila (14) on varustettu rinnakkaisilla viistoilla lamelleilla (16), joiden välitse liuos pääsee virtaamaan ylöspäin.
- 5 16. Jonkin patenttivaatimuksista 7-14 mukainen haihdutin, **tunnettu** siitä, että kaukalomaisessa nesteenjako-tilassa (14) on sen alempaan ja ylempään osaan (17, 18) jakava välipohja (27), että kierrätysjohto (11) liittyy sivusuuntaisesti nesteenjako-tilan alempaan osaan (17) ja että välipohjassa on virtausaukkoja, joista liuos pääsee virtaamaan tilan ylempään osaan (18) samalla kun sakka (23) päättyy tilan pohjasta alkavaan poistojohtoon (21).
- 10 17. Patenttivaatimuksen 16 mukainen haihdutin, **tunnettu** siitä, että välipohjan (27) aukkojen muodostamat virtaustiet on kallistettu vastavirtaan kierrätysvirtauksen tulosuuntaan nähden.
- 15 18. Jonkin patenttivaatimuksen 15-17 mukainen haihdutin, **tunnettu** siitä, että kaukalomainen nesteenjako-tila (14) on varustettu patolevyllä (15), jonka yli liuos virtaa rinnakkaisten lämmönvaihdinelementtien syöttöyhteisiin (6) ylivuotona.
19. Jonkin patenttivaatimuksista 7-18 mukainen haihdutin, **tunnettu** siitä, että poistojohto (21) johtaa selkeyttimeen (24), joka erottaa sakan sen mukana olevasta nestefaasista, ja että selkeytin on kytketty johdolla (26) kierrätysjohtoon (11) erottuneen nestefaasin yhdistämiseksi haihduttimessa tapahtuvaan kierrätysvirtaukseen.

(57) Tiivistelmä

Keksintö koskee menetelmää liuoksen haihduttamiseksi sekä siihen soveltuvaa haihdutinta. Haihdutin (1) käsittää vaipan (2) sisään sovitettuja rinnakkaisia, levymäisiä lämmönvaihdinelementtejä (3), jotka voivat muodostua taipuisasta muovikalvosta, sekä elementeille yhteisen nestejakotilan (14), josta haihdutettava liuos on syöttökanavien (6) kautta levitettävissä elementtien lämmönsiirtopinnoille (4) valumaan niillä ylhäältä alaspäin. Pinnoilla haihtumatta jäänyt liuos (10) kierrätetään haihduttimen pohjalta takaisin nestejakotilaan ja siitä elementtien lämmönsiirtopinnoille (4) uutta haihdutuskertaa varten. Haihdutuksen yhteydessä liuoksesta erottuu ylikyllästymisen seurauksena sakkaa, joka päättyy liuoksen mukana kierrätysvirtaukseen ja joka keksinnön mukaan erotetaan liuoksesta sakanerottimena toimivassa nestejakotilassa (14). Kierrätysvirtaus syötetään tilaan (14) siten, että mukana oleva sakka erottuu painonsa ja/tai liike-energiansa vaikutuksesta samalla, kun liuoksen virtaus suuntautuu ylöspäin ja päättyy elementtien lämmönsiirtopinnoille (4) johtaviin syöttökanaviin (6). Tila (14) voi muodostua pitkänomaisesta putkesta, jonka päähän virtaus syötetään alaspäin kaartuvasta kierrätysjohdosta, tai tilan voi muodostaa kaukalo, joka on varustettu sakkaa erottavilla lamelleilla (16) tai reiällisellä välipohjalla.

Kuvio 1

PCT REQUEST

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0	For receiving Office use only	
0-1	International Application No.	
0-2	International Filing Date	
0-3	Name of receiving Office and "PCT International Application"	
0-4	Form - PCT/RO/101 PCT Request	
0-4-1	Prepared using	PCT-EASY Version 2.90 (updated 08.03.2000)
0-5	Petition The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	Receiving Office (specified by the applicant)	National Board of Patents and Registration (Finland) (RO/FI)
0-7	Applicant's or agent's file reference	49538
I	Title of invention	A PROCESS FOR EVAPORATING A SOLUTION AND AN EVAPORATOR FOR USE IN THE PROCESS
II	Applicant	
II-1	This person is:	applicant only
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III-2	Applicant and/or inventor	
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V	Designation of States	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AP: GH GM KE LS MW SD SL SZ TZ UG ZW and any other State which is a Contracting State of the Harare Protocol and of the PCT EA: AM AZ BY KG KZ MD RU TJ TM and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT EP: AT BE CH&LI CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE and any other State which is a Contracting State of the European Patent Convention and of the PCT OA: BF BJ CF CG CI CM GA GN GW ML MR NE SN TD TG and any other State which is a member State of OAPI and a Contracting State of the PCT

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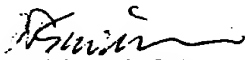
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V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AE AG AL AM AT AU AZ BA BB BG BR BY CA CH&LI CN CR CU CZ DE DK DM DZ EE ES FI GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MA MD MG MK MN MW MX NO NZ PL PT RO RU SD SE SG SI SK SL TJ TM TR TT TZ UA UG US UZ VN YU ZA ZW	
V-5	Precautionary Designation Statement In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.		
V-6	Exclusion(s) from precautionary designations	NONE	
VI-1	Priority claim of earlier national application		
VI-1-1	Filing date	01 April 1999 (01.04.1999)	
VI-1-2	Number	990735	
VI-1-3	Country	FI	
VI-2	Priority document request The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1	
VII-1	International Searching Authority Chosen	Swedish Patent Office (ISA/SE)	
VIII	Check list	number of sheets	electronic file(s) attached
VIII-1	Request	4	-
VIII-2	Description	7	-
VIII-3	Claims	3	-
VIII-4	Abstract	1	49538.txt
VIII-5	Drawings	4	-
VIII-7	TOTAL	19	
	Accompanying items	paper document(s) attached	electronic file(s) attached
VIII-8	Fee calculation sheet	✓	-
VIII-9	Separate signed power of attorney	✓	-
VIII-16	PCT-EASY diskette	-	diskette
VIII-17	Other (specified):	Copy of Official Action in FI 990735	-
VIII-18	Figure of the drawings which should accompany the abstract	1	
VIII-19	Language of filing of the international application	Finnish	

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IX-1	Signature of applicant or agent	
IX-1-1	Name	BERGGREN OY AB
IX-1-2	Name of signatory	Olli-Pekka Saijonmaa
IX-1-3	Capacity	Patent Agent

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10-1	Date of actual receipt of the purported international application	
10-2	Drawings:	
10-2-1	Received	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/SE
10-6	Transmittal of search copy delayed until search fee is paid	

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11-1	Date of receipt of the record copy by the International Bureau	
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0	For receiving Office use only	
0-1	International Application No.	
0-2	Date stamp of the receiving Office	
0-4	Form - PCT/RO/101 (Annex) PCT Fee Calculation Sheet	
0-4-1	Prepared using	PCT-EASY Version 2.90 (updated 08.03.2000)
0-9	Applicant's or agent's file reference	49538
2	Applicant	HADWACO LTD OY, et al.
12	Calculation of prescribed fees	fee amount/multiplier total amounts (FIM)
12-1	Transmittal fee T	⇒ 800
12-2	Search fee S	⇒ 5 618
12-3	International fee Basic fee (first 30 sheets) b1	2 431,8
12-4	Remaining sheets	0
12-5	Additional amount (X)	53,51
12-6	Total additional amount b2	0
12-7	b1 + b2 = B	2 431,8
12-8	Designation fees Number of designations contained in international application	85
12-9	Number of designation fees payable (maximum 8)	8
12-10	Amount of designation fee (X)	523,22
12-11	Total designation fees D	4 185,76
12-12	PCT-EASY fee reduction R	-749,16
12-13	Total international fee (B+D-R) I	⇒ 5 868,4
12-14	Fee for priority document Number of priority documents requested	1
12-15	Fee per document (X)	422
12-16	Total priority document fee P	⇒ 422
12-17	TOTAL FEES PAYABLE (T+S+I+P)	⇒ 12 708,4
12-19	Mode of payment	cheque

VALIDATION LOG AND REMARKS

13-2-1	Validation messages Request	Green? A translation of the international application into English will have to be prepared under the responsibility of the ISA selected.
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PCT (ANNEX - FEE CALCULATION SHEET)

49538

Original (for SUBMISSION) - printed on 31.03.2000 08:14:27 AM

		Green? Please note that the entire request (including the title of invention) must be in English
13-2-3	Validation messages Names	Green? Applicant 1.:Telephone No. missing
		Green? Applicant 1.:Facsimile No. missing
13-2-7	Validation messages Fees	Green? Please verify that modified fee amounts are correct.

Original (for **SUBMISSION**) - printed on 31.03.2000 08:14:27 AM**PCT-EASY INFORMATION SHEET**

(For applicant use only, DO NOT submit this sheet with the international application)

VALIDATION LOG

	Request
Green?	A translation of the international application into English will have to be prepared under the responsibility of the ISA selected.
Green?	Please note that the entire request (including the title of invention) must be in English
	Names
Green?	Applicant 1.:Telephone No. missing
Green?	Applicant 1.:Facsimile No. missing
	Fees
Green?	Please verify that modified fee amounts are correct.

Before submitting the International Application, please carefully verify that:

- the information contained on printed Request form is correct;
- Box IX of the Request form has been signed;
- all elements of the international application as indicated in Box VIII of the Request form have been attached; and,
- the diskette containing the PCT-EASY zip file of the International Application has been enclosed and has been clearly labeled "PCT-EASY", with the applicant's or agent's file reference, and the first applicant's name.

ATTENTION

DO NOT modify any indications on the Request form printout. The attached PCT-EASY application has been locked. If an error or an omission is discovered at this time, you must copy the submitted application as a template and make the change or correction in a new application (using the submitted application as a template). You may create such a template by copying the submitted application from the "Stored Forms" folder to the "New PCT Forms" folder. Open the new (.0WO) file created in the "New PCT Forms" folder, correct the errors and proceed with the submission process again.

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 49538	FOR FURTHER ACTION		See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/FI00/00278	International filing date (<i>day/month/year</i>) 31.03.2000	Priority date (<i>day/month/year</i>) 01.04.1999	
International Patent Classification (IPC) or national classification and IPC ₇ B01D 1/22			
Applicant HADWACO LTD OY et al			

- This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
- This REPORT consists of a total of 4 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 3 sheets.

- This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 25.10.2000	Date of completion of this report 05.03.2001
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88	Authorized officer Bengt Christensson/MP Telephone No. 08-782 25 00

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/FI00/00278

I. Basis of the report

1. With regard to the **elements** of the international application:*

- ☐ the international application as originally filed
- ☒ the description:
pages 1-8, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____
- ☐ the claims:
pages _____, as originally filed
pages _____, as amended (together with any statement) under article 19
pages 9-11, filed with the demand
pages _____, filed with the letter of _____
- ☒ the drawings:
pages 1-4, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____
- ☐ the sequence listing part of the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.These elements were available or furnished to this Authority in the following language English which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☒ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheet/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/FI00/00278

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**1. Statement**

Novelty (N)	Claims	<u>1-17</u>	YES
	Claims	_____	NO
Inventive step (IS)	Claims	<u>1-17</u>	YES
	Claims	_____	NO
Industrial applicability (IA)	Claims	<u>1-17</u>	YES
	Claims	_____	NO

2. Citations and explanations (Rule 70.7)

The claimed invention relates to a method for evaporating a solution, as well as an evaporator for use in the method.

In evaporators, where a portion of treated solution or suspension that has not evaporated is recycled back onto heat transmission surfaces to achieve a sufficient degree of evaporation, there is a problem. Solid matter, falling from between elements onto the bottom of the evaporator, gets into the liquid circulation flow. This can result in the possible blockage of the narrow liquid distribution channels at the upper ends of the elements, from where liquid is fed onto the surfaces of the elements. As the efficiency of evaporation is crucially dependent on an even spreading of liquid onto the heat transmission surfaces of the elements, the precipitate and other solid matter must be removed from the circulation flow in order to prevent blockages in the feeding channels.

This objective is achieved in that the solution is fed from a liquid distribution space. The liquid to be recycled is fed to the distribution space so that the precipitate in the solution is separated in the space under the effect of its weight and/or its kinetic energy. At the same time, the flow of the solution is directed upwards, and the precipitate is removed into an exhaust pipe.

A flow evaporator header is described in US-A-3 724 522 (fig. 1,2 & column 2, line 46-column 3, line 13). A desalinisation system comprises a tank (10) containing therein a vertically oriented falling film evaporator panel (12) with an overflow header (14) mounted on the top thereof. Sea water is drawn into the tank (10) through an input pipe (16). A brine pump (27) drains the brine solution from the bottom of the tank

.../...

Supplemental Box

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V.

(10) to the overflow header (14). The header (14) is specifically constructed to discharge the brine solution in uniform volumetric flow per unit area out of the upper surface of the overflow header (14). A film of brine solution is evenly distributed and flows downwardly over the vertical exterior surfaces of the evaporator panel (12). This falling film of brine solution is heated by the high temperature steam within the evaporator panel (12), and boils off produced steam, which is then drawn off by the steam compressor (22).

A header duct (38) has an open upper edge portion (54) upon which there is carried a fluid exit port (56) (column 2, lines 4-23).

The velocity of the fluid in the boundary layer adjacent the interior surface of a lower wall (52) at a second end (42) of the header duct (38) is maintained. Fluid stagnation in this region is prevented and the consequent settling out of salts and other solid materials within the header duct is achieved (38) (column 4, lines 38-54).

This document is cited in the International Search Report as a document of particular relevance and is now considered to show the closest background art. The reason for this re-evaluation is that the method for evaporating according to amended claim 1 of October 25, 2000 differs from the evaporator according to the document in that the precipitate is separated under the combined effect of gravity and centrifugal forces.

The method for evaporating according to claim 1 is considered to give rise to an unexpected technical effect, i.e. removing the solid matter originating not only from the heat transmission surfaces but also the recycling tube systems. Thus, this claim is not considered to be obvious for a person skilled in the art.

The essential technical features of independent claim 6 are similar to those in claim 1. Thus, this claim is novel and considered to have an inventive step.

In accordance with the arguments stated above, the invention in claims 1-17 is novel, is considered to involve an inventive step and has industrial applicability.

25 -10- 2000

Claims

1. A method of evaporating a solution, comprising feeding the solution to heat transmission surfaces (4) of parallel plate-formed heat exchanger elements (3) of an evaporator (1), from supply units (6, 31) spreading the solution to the top of said surfaces to flow downwards, removing the part of the solution (10) remaining from the evaporation and precipitate formed in connection with the evaporation from the lower end of the evaporator, and recycling said remaining part of the solution (10) back to the heat transmission surfaces (4) for re-evaporation, said recycling comprising conducting the solution to a liquid distribution space (14) common to said heat exchanger elements (3), separating the precipitate (23) from the solution in said distribution space, the solution forming an upward flow in the distribution space, and passing the solution to said supply units (6, 31) for being spread onto the heat transmission surfaces (4), characterized in that the recycled solution is fed to the liquid distribution space (14) from a downwardly curved conduit (11) as a curved flow, to separate the precipitate (23) under the combined effect of gravity and centrifugal force, and the precipitate as separated is discharged to an exhaust pipe (21) from the bottom of the liquid distribution space.
2. A method according to Claim 1, **characterized** in that the solution to be recycled is fed into a narrow, elongated liquid distribution space (14) from its one end, and that the precipitate is removed into an exhaust pipe (21) from the opposite end of the space.
3. A method according to any of the preceding Claims, **characterized** in that the solution to be recycled is fed underneath parallel lamellas (16) or an intermediate bottom (27) provided with ports (28-30), which are located in the liquid distribution space (14), so that the flow of the solution winds towards the ports of the intermediate bottom or the flow channels (22) between the lamellas, and the precipitate (23) is separated from the flow under the effect of centrifugal force.
4. A method according to any of the preceding Claims, **characterized** in that the precipitate is lead through an exhaust pipe (21) to a settling apparatus (25), where the precipitate is separated from the liquid phase that comes with it, after which the liquid phase is connected to the recirculation flow of the solution that takes place in the evaporator.

5. A method according to any of the preceding Claims, **characterized** in that the evaporator is a film evaporator consisting of heat exchanger elements (3) made of flexible film material, such as plastic film.
6. An evaporator (1) comprising a jacket (2), parallel upright plate heat exchanger elements (3) fitted inside the jacket, said elements having upright heat transmission surfaces (4), supply units (6, 31) for spreading a solution to be evaporated to the top of said heat transmission surfaces to flow downwards on said surfaces, a liquid distribution space (14) common to said heat exchanger elements for feeding the solution to said supply units, means for removing the part of the solution (10) remaining from the evaporation and precipitate formed in connection with the evaporation from the lower end of the evaporator and for recycling said remaining part of the solution (10) back to the heat transmission surfaces (4) for re-evaporation, said recycling means comprising a conduit (11) connecting said lower end of the evaporator with said liquid distribution space (14), said space having means for separating the precipitate (23) from the solution being recycled, characterized in that said conduit (11) for recycling the solution forms a downward curve connected to the liquid distribution space (14), to feed the solution to said space as a curved flow and to separate the precipitate (23) under the combined effect of gravity and centrifugal force, and that an exhaust pipe (21) for discharging the precipitate as separated starts from the bottom of the liquid distribution space.
7. An evaporator according to Claim 6, **characterized** in being a film evaporator consisting of heat exchanger elements (3) made of flexible film material, such as plastic film.
8. An evaporator according to Claim 6 or 7, **characterized** in that the liquid distribution space (14) is located inside the evaporator jacket (2).
9. An evaporator according to any of Claims 6 to 8, **characterized** in that the recirculation line (11) is attached to one end of the elongated liquid distribution space (14), and that the exhaust pipe (21) for the precipitate starts from the opposite end of the liquid distribution space.
10. An evaporator according to any of Claims 6 to 9, **characterized** in that the bottom of the liquid distribution space (14) is slanted downwards towards the exhaust pipe (21).

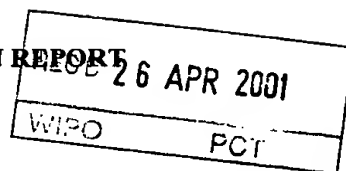
11. An evaporator according to any of Claims 6 to 10, **characterized** in that the liquid distribution space (14) converges in a sphenoid or conic form towards the exhaust pipe (21).
12. An evaporator according to any of Claims 6 to 11, **characterized** in that the supply units comprise distributive nozzles (31) that start from the liquid distribution space (14) and spread out like fans, each one of them feeding solution to several parallel gaps between the heat transmission surfaces (4) of the heat exchanger elements (3), evaporation taking place in the gaps.
13. An evaporator according to any of Claims 6 to 12, **characterized** in that the trough-like liquid distribution space (14) is provided with parallel, slanting lamellas (16), between which the solution is allowed to flow upwards.
14. An evaporator according to any of Claims 6 to 12, **characterized** in that the trough-like liquid distribution space (14) comprises an intermediate bottom (27) that divides it into a lower and upper part (17, 18), that the recirculation line (11) is attached, in the lateral direction, to the lower part (17) of the liquid distribution space, and that the intermediate bottom comprises ports, through which the solution is allowed to flow to the upper part (18) of the space at the same time as the precipitate (23) ends up in the exhaust pipe (21) that starts from the bottom of the space.
15. An evaporator according to Claim 14, **characterized** in that the flow routes formed by the openings in the intermediate bottom (27) are slanted upstream with regard to the incoming direction of the recirculation flow.
16. An evaporator according to any of Claims 13 to 15, **characterized** in that the trough-like liquid distribution space (14) is provided with a dam plate (15), over which the solution flows as an overflow to the supply units (6) of the parallel heat exchanger elements.
17. An evaporator according to any of Claims 6 to 16, **characterized** in that the exhaust pipe (21) leads to a settling apparatus (24), which separates the precipitate from the liquid phase that comes with it, and that the settling apparatus is connected, by using a line (26), to the recirculation line (11) in order to join the separated liquid phase to the recirculation flow in the evaporator.

TENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)



Applicant's or agent's file reference 49538	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/FI00/00278	International filing date (day/month/year) 31.03.2000	Priority date (day/month/year) 01.04.1999
International Patent Classification (IPC) or national classification and IPC B01D 1/22		
Applicant HADWACO LTD OY et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 3 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 25.10.2000	Date of completion of this report 05.03.2001
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88	Authorized officer Bengt Christensson/MP Telephone No. 08-782 25 00

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/FI00/00278

I. Basis of the report

1. With regard to the **elements** of the international application:*

- ☐ the international application as originally filed
- ☒ the description:
pages 1-8, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____
- ☐ the claims:
pages _____, as originally filed
pages _____, as amended (together with any statement) under article 19
pages 9-11, filed with the demand
pages _____, filed with the letter of _____
- ☒ the drawings:
pages 1-4, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____
- ☐ the sequence listing part of the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.These elements were available or furnished to this Authority in the following language English which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☒ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheet/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/FI00/00278

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	<u>1-17</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1-17</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1-17</u>	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

The claimed invention relates to a method for evaporating a solution, as well as an evaporator for use in the method.

In evaporators, where a portion of treated solution or suspension that has not evaporated is recycled back onto heat transmission surfaces to achieve a sufficient degree of evaporation, there is a problem. Solid matter, falling from between elements onto the bottom of the evaporator, gets into the liquid circulation flow. This can result in the possible blockage of the narrow liquid distribution channels at the upper ends of the elements, from where liquid is fed onto the surfaces of the elements. As the efficiency of evaporation is crucially dependent on an even spreading of liquid onto the heat transmission surfaces of the elements, the precipitate and other solid matter must be removed from the circulation flow in order to prevent blockages in the feeding channels.

This objective is achieved in that the solution is fed from a liquid distribution space. The liquid to be recycled is fed to the distribution space so that the precipitate in the solution is separated in the space under the effect of its weight and/or its kinetic energy. At the same time, the flow of the solution is directed upwards, and the precipitate is removed into an exhaust pipe.

A flow evaporator header is described in US-A-3 724 522 (fig. 1,2 & column 2, line 46-column 3, line 13). A desalinisation system comprises a tank (10) containing therein a vertically oriented falling film evaporator panel (12) with an overflow header (14) mounted on the top thereof. Sea water is drawn into the tank (10) through an input pipe (16). A brine pump (27) drains the brine solution from the bottom of the tank

.../...

Supplemental Box

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V.

(10) to the overflow header (14). The header (14) is specifically constructed to discharge the brine solution in uniform volumetric flow per unit area out of the upper surface of the overflow header (14). A film of brine solution is evenly distributed and flows downwardly over the vertical exterior surfaces of the evaporator panel (12). This falling film of brine solution is heated by the high temperature steam within the evaporator panel (12), and boils off produced steam, which is then drawn off by the steam compressor (22).

A header duct (38) has an open upper edge portion (54) upon which there is carried a fluid exit port (56) (column 2, lines 4-23).

The velocity of the fluid in the boundary layer adjacent the interior surface of a lower wall (52) at a second end (42) of the header duct (38) is maintained. Fluid stagnation in this region is prevented and the consequent settling out of salts and other solid materials within the header duct is achieved (38) (column 4, lines 38-54).

This document is cited in the International Search Report as a document of particular relevance and is now considered to show the closest background art. The reason for this re-evaluation is that the method for evaporating according to amended claim 1 of October 25, 2000 differs from the evaporator according to the document in that the precipitate is separated under the combined effect of gravity and centrifugal forces.

The method for evaporating according to claim 1 is considered to give rise to an unexpected technical effect, i.e. removing the solid matter originating not only from the heat transmission surfaces but also the recycling tube systems. Thus, this claim is not considered to be obvious for a person skilled in the art.

The essential technical features of independent claim 6 are similar to those in claim 1. Thus, this claim is novel and considered to have an inventive step.

In accordance with the arguments stated above, the invention in claims 1-17 is novel, is considered to involve an inventive step and has industrial applicability.

Claims

1. A method for evaporating a solution, comprising the spreading of the solution on the heat transmission surfaces (4) of the parallel, plate heat exchanger elements (3) of an evaporator (1) to run from the top downwards, the solution being fed from
5 a liquid distribution space (14) common to the elements, the solution (10) that remains on the heat transmission surfaces without evaporating and the precipitate that is formed in connection with evaporation are removed from the lower end of the evaporator, and the solution that has not evaporated is recycled back to the heat transmission surfaces for re-evaporation, characterized in that the solution to be
10 recycled is fed to the liquid distribution space (14) so that the precipitate (23) in the solution is separated in the space under the effect of its weight and/or its kinetic energy at the same time as the flow of the solution is directed upwards, that the precipitate is removed into an exhaust pipe (21) that begins from the bottom of the space, and that the solution is directed from the space to the supply units (6, 31) that
15 lead to the heat transmission surfaces (4) of the elements.
2. A method according to Claim 1, characterized in that the solution to be recycled is fed to the liquid distribution space (14) from the top downwards in the form of a flow (11) that curves towards the side or the end of the space.
3. A method according to Claim 1 or 2, characterized in that the solution to be
20 recycled is fed into a narrow, elongated liquid distribution space (14) from its one end, and that the precipitate is removed into an exhaust pipe (21) from the opposite end of the space.
4. A method according to any of the preceding Claims, characterized in that the
25 solution to be recycled is fed underneath parallel lamellas (16) or an intermediate bottom (27) provided with ports (28-30), which are located in the liquid distribution space (14), so that the flow of the solution winds towards the ports of the intermediate bottom or the flow channels (22) between the lamellas, and the precipitate (23) is separated from the flow under the effect of centrifugal force.
5. A method according to any of the preceding Claims, characterized in that the
30 precipitate is lead through an exhaust pipe (21) to a settling apparatus (25), where the precipitate is separated from the liquid phase that comes with it, after which the liquid phase is connected to the recirculation flow of the solution that takes place in the evaporator.

6. A method according to any of the preceding Claims, characterized in that the evaporator a film evaporator consisting of heat exchanger elements (3) made of flexible film material, such as plastic film.

5 7. An evaporator (1) comprising a jacket (2), parallel plate heat exchanger elements (3) fitted inside the jacket, the solution to be evaporated being arranged to run on the heat transmission surfaces (4) of the elements from the top downwards, a liquid distribution space (14), from where the solution to be evaporated can be spread, through supply units (6, 31), on the parallel heat transmission surfaces from their upper ends, members for removing the solution (10) that has not evaporated and the precipitate, which has generated in connection with evaporation, from the 10 lower end of the evaporator, and a line (11) for recycling the solution that has not evaporated back to heat transmission surfaces of the elements for re-evaporation, characterized in that the liquid distribution space (14) also constitutes a separator of precipitate, where the recirculation line (11) feeds the solution into the space 15 through its side or face, and the space is provided with an exhaust pipe (21) that starts from its bottom, so that the precipitate (23) in the recycled flow is separated in the liquid distribution space under the effect of its weight and/or kinetic energy, ending up in the exhaust pipe at the same time as the flow of recycled solution is directed upwards towards the supply units (6, 31) leading to the heat transmission 20 surfaces (4) of the elements (3).

8. An evaporator according to Claim 7, characterized in being a film evaporator consisting of heat exchanger elements (3) made of flexible film material, such as plastic film.

9. An evaporator according to Claim 7 or 8, characterized in that the liquid 25 distribution space (14) is located inside the evaporator jacket (2).

10. An evaporator according to any of Claims 7 to 9, characterized in that the recirculation line (11) is attached to one end of the elongated liquid distribution space (14), and that the exhaust pipe (21) for the precipitate starts from the opposite end of the liquid distribution space.

30 11. An evaporator according to any of Claims 7 to 10, characterized in that the recirculation line (11) is attached to the liquid distribution space (14) so that it curves from the top downwards.

12. An evaporator according to any of Claims 7 to 11, characterized in that the bottom of the liquid distribution space (14) is slanted downwards towards the exhaust pipe (21).
13. An evaporator according to any of Claims 7 to 12, characterized in that the liquid distribution space (14) converges in a sphenoid or conic form towards the exhaust pipe (21).
14. An evaporator according to any of Claims 7 to 13, characterized in that the supply units comprise distributive nozzles (31) that start from the liquid distribution space (14) and spread out like fans, each one of them feeding solution to several parallel gaps between the heat transmission surfaces (4) of the heat exchanger elements (3), evaporation taking place in the gaps.
15. An evaporator according to any of Claims 7 to 14, characterized in that the trough-like liquid distribution space (14) is provided with parallel, slanting lamellas (16), between which the solution is allowed to flow upwards.
16. An evaporator according to any of Claims 7 to 14, characterized in that the trough-like liquid distribution space (14) comprises an intermediate bottom (27) that divides it into a lower and upper part (17, 18), that the recirculation line (11) is attached, in the lateral direction, to the lower part (17) of the liquid distribution space, and that the intermediate bottom comprises ports, through which the solution is allowed to flow to the upper part (18) of the space at the same time as the precipitate (23) ends up in the exhaust pipe (21) that starts from the bottom of the space.
17. An evaporator according to Claim 16, characterized in that the flow routes formed by the openings in the intermediate bottom (27) are slanted upstream with regard to the incoming direction of the recirculation flow.
18. An evaporator according to any of Claims 15 to 17, characterized in that the trough-like liquid distribution space (14) is provided with a dam plate (15), over which the solution flows as an overflow to the supply units (6) of the parallel heat exchanger elements.
19. An evaporator according to any of Claims 7 to 18, characterized in that the exhaust pipe (21) leads to a settling apparatus (24), which separates the precipitate from the liquid phase that comes with it, and that the settling apparatus is

connected, by using a line (26), to the recirculation line (11) in order to join the separated liquid phase to the recirculation flow in the evaporator.

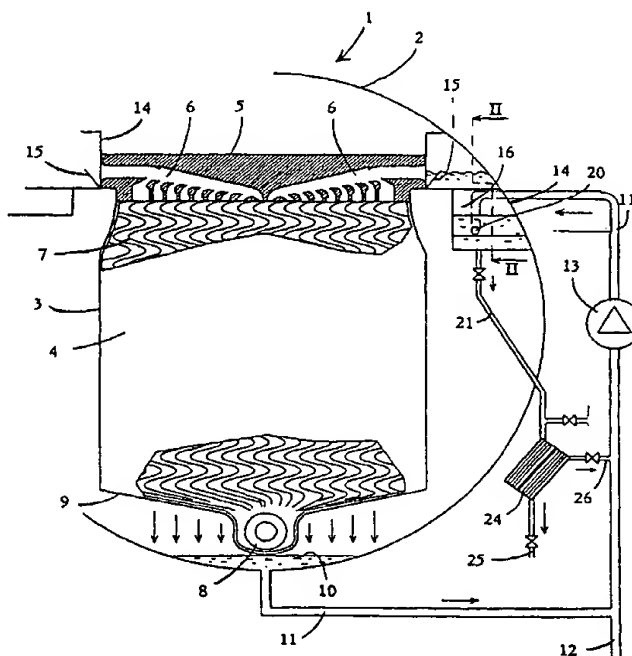
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(54) Title: A PROCESS FOR EVAPORATING A SOLUTION AND AN EVAPORATOR FOR USE IN THE PROCESS

(57) Abstract

The invention relates to a method for evaporating a solution and an evaporator applied to it. The evaporator (1) comprises parallel plate heat exchanger elements (3) fitted inside a jacket (2), consisting of a flexible plastic film, for example, and a liquid distribution space (4) common to the elements, from where the solution to be evaporated can be spread, through supply channels (6), on the heat transmission surfaces (4) of the elements to run from the top downwards. The solution (10) that has not evaporated on the surfaces is recycled from the bottom of the evaporator back to the liquid distribution space, and from there to the heat transmission surfaces (4) of the elements for re-evaporation. In connection with evaporation, precipitate is separated from the solution as a result of over-saturation, ending up in the recirculation flow with the solution and, according to the invention, being separated from the solution in the liquid distribution space (14) that works as a separator for the precipitate. The recirculation flow is fed into the space (14) so that the precipitate in it is separated under the effect of its weight and/or kinetic energy, while the flow of the solution is directed upwards, ending up in the supply channels (6) leading to the heat transmission surfaces (4) of the elements. The space (14) can consist of an elongated duct, the flow being fed to its end from a downward curving recirculation line, or the space can consist of a trough, which is provided with lamellas (16) or a perforated intermediate bottom, which separate the precipitate.



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A process for evaporating a solution and an evaporator for use in the process

The object of the invention is a method for evaporating a solution, comprising the spreading of the solution on the heat transmission surfaces of the parallel, plate heat exchanger elements of an evaporator to run from the top downwards, the solution
5 being fed from a liquid distribution space common to both elements; the solution that remains on the heat transmission surfaces without evaporating and the precipitate that is formed in connection with evaporation are removed from the lower end of the evaporator, and the solution that has not evaporated is recycled
10 back to the heat transmission surfaces for re-evaporation. Furthermore, the invention is directed at the evaporator used in the said method.

The publications FI 79948 and 86961 describe heat exchangers made of bag-like heat transmission elements consisting of film material, such as plastic, which are suitable, among others, for distillation and for concentrating various suspensions. In
15 the heat exchanger, the elements are tied against one another to form a pack, in which water is lead to the outer surfaces of the elements to be evaporated, and then the evaporated steam is compressed to a higher pressure and temperature by a compressor and conducted inside the elements to constitute heating steam, which in the heat transmission is condensed back into water.

20 The degree of saturation of the components dissolved in the concentration of solutions by evaporation grows, and when the saturation point is exceeded, precipitation results. As examples, we could mention the calcium oxalate precipitated from the bleaching effluents of chemical pulp, the calcium carbonate, calcium sulphate, and calcium silicate, as well as possible iron compounds
25 precipitated from subsoil waters, the denaturised proteins precipitated from the waster water of the food industry, and salts such as gypsum and iron salts or hydroxides precipitated from mineral-bearing waste water. In the heat exchangers according to the publications mentioned above, the precipitate formed on the film surfaces, as well as the solid matter contained by the suspensions that are treated,
30 are easily accumulated into the form of a cake between the bag-like elements, impeding heat transmission and the flow of liquid and steam, which is why the gaps between the elements must perhaps be cleaned from time to time. However, the FI application No. 970273 discloses an evaporator with improved shapes of elements, so that, during evaporation, the precipitate or other solid matter fall from between

the elements onto the bottom of the evaporator; in other words, regarding the elements, the evaporator is self-cleaning.

In evaporators, where the portion of the treated solution or suspension that has not evaporated is recycled back onto the heat transmission surfaces to achieve a sufficient degree of evaporation, one problem remains: the solid matter falling from between the elements onto the bottom of the evaporator gets into the liquid circulation flow, possibly blocking the narrow liquid distribution channels at the upper ends of the elements, from where liquid is fed onto the surfaces of the elements. As the efficiency of evaporation is crucially dependent on an even spreading of liquid onto the heat transmission surfaces of the elements, the precipitate and other solid matter must be removed from the circulation flow in order to prevent blockages in the feeding channels.

The problem with blocking could be alleviated by simply providing the circulation line with a separation device, such as a filter, a cyclone, or a sedimentator, which would separate the precipitate from the liquid before it is recycled back to the evaporation phase, as mentioned above. However, from the point of view of space utilization and costs, this solution would be disadvantageous; in addition, the pressure loss caused by the separator increases the use of energy needed for pumping. If the separator is located at the suction face of the circulation pump, the pressure loss can cause cavitation of the pump. Furthermore, the solid matter coming off from the walls of the recycling tube system subsequent to the separator, which would end up in the liquid distribution channels of the elements, remains a problem.

To avoid the disadvantages mentioned above, according to the invention, the separation of the precipitate or other solid matter from the solution recycled to re-evaporation is arranged so as to take place in connection with the distribution of the liquid to the feeding flow leading to the heat transmission surfaces of the various elements of the evaporator. The method according to the invention is characterized in that the recycled solution is fed to the liquid distribution space so that the precipitate in the solution is separated in the space under the effect of its weight and/or kinetic energy at the same time as the flow of the solution is directed upwards, that the precipitate is removed to the exhaust pipe that starts from the bottom of the space, and that the solution is conducted from the space to the feeding units leading to the heat transmission surfaces of the elements.

Regarding the essential features of the evaporator according to the invention, which can be used to implement the evaporation method described above, we refer to the appended Claims, Claim 7 in particular.

- 5 The invention is suitable for film evaporators in particular, in which bag-like heat exchanger elements consist of flexible film material, such as plastic film. In these, the precipitate can come off from the heat transmission surfaces not only in connection with washing, but also during a run; in other words, they can be self-cleaning, so that it is essential to remove the loosened precipitate from the solution circulation flow.
- 10 According to the invention, by connecting the separation of precipitate to the solution feeding that goes to the heat transmission surfaces it is possible to remove, from the solution, the solid matter originating in not only the heat transmission surfaces but also the recycling tube systems, just before the feeding phase, which is the most crucial phase with regard to blocking. The separation of the precipitate
- 15 thus arranged does not impede the washing of the evaporator, where large amounts of loosening precipitate go to the wash water, which is removed from the bottom of the evaporator. With respect to the utilization of space and the functionality, it is preferable to locate the liquid distribution space inside the evaporator jacket.

- The liquid distribution space can preferably be designed as an elongated duct, one
- 20 end of which is connected to the recirculation line of the solution, and the opposite end is provided with an exhaust pipe for the precipitate. In this solution, the feeding units leading to the heat transmission surfaces are preferably distributive nozzles that begin from the liquid distribution space and spread out like fans, and each one of them feeds solution to several parallel gaps between the heat transmission
- 25 surfaces of the heat exchanger elements, where evaporation takes place. Before joining the liquid distribution space, the recirculation line preferably forms a curve directed towards the space downwards from above, which causes the centrifugal force to press the precipitate to the circumference of the line and to the bottom of the liquid distribution space, which is its extension, already at the stage when the
- 30 solution is coming. The precipitate then drifts, in the form of a bottom flow, along the shortest route from the space to the exhaust pipe.

- Alternatively, the liquid distribution space can consist of an elongated trough, which can be provided with parallel, slanting lamellas, under which the recycled solution is fed and between which the solution can flow upwards. In that case, the
- 35 flow of the solution winds into the flow channels between the lamellas, which are

directed upwards, while the precipitate at the same time is separated from the flow under the effect of centrifugal force. This separation based on the kinetic energy of the precipitate is effective especially, when the lamellas are sloped upstream with respect to the incoming direction of the circulated flow. The said curvature of the recirculation line of the solution is advantageous also in this application.

In addition to or instead of the kinetic energy of the precipitate particles, gravitational force can be utilized in the separation of the precipitate by arranging laminar flowing conditions in the liquid distribution space so that the space with its slanting lamellas works as a lamellate settling apparatus. The sedimentation of the particles is advanced, if the bottom of the liquid distribution space is downwards slanting in the incoming direction of the circulated flow.

Furthermore, it is preferable to design the liquid distribution space or its lower part so that it converges, in the incoming direction of the circulated flow, in a sphenoid or conic form towards the exhaust pipe that starts from the opposite side of the space to the recirculation line. In that case, the speed of the stream flow can be kept essentially stable so that, in the space, an even upward flow and an even distribution of liquid to the feeding units of the various heat transmission elements is provided.

Instead of the said slanting lamellas, the trough-like liquid distribution space can be provided with an intermediate bottom that divides it into a lower and upper part, comprising the necessary ports for up flow. The ports can be slanting and the walls defining them can have a more or less lamella-type shape to enhance the separation of the precipitate, or the intermediate bottom can have separating members that permeate the flow, such as cyclones or slanting or curved pipes that serve as flow channels.

The precipitate, which is separated from the liquid distribution space to the exhaust pipe, can be lead to a clarifier, where the precipitate is separated from the liquid that comes with it, the amount of the liquid generally being about 3-50%, preferably 3-25%, of the total amount of the flow circulated in the evaporator, whereupon the liquid can be returned to the recycled flow.

In the following, the invention is described in detail with the aid of examples and with reference to the appended drawings, in which:

Fig. 1 shows a cross section of an evaporator according to the invention, comprising heat transmission elements made of film material, and liquid circulation channels that have the separation of solid matter arranged in them,

Fig. 2 shows the liquid distribution trough of the evaporator in section II-II of Fig. 1,

Fig. 3 shows, like Fig. 2, the liquid distribution trough according to another embodiment of the invention,

5 Fig. 4 is the horizontal section IV-IV of Fig. 3,

Fig. 5 shows the lower part and the intermediate bottom, provided with precipitate separation members, of the liquid distribution trough in accordance with a third embodiment of the invention,

10 Fig. 6 shows a fifth embodiment of the invention, where parallel distributive nozzles are connected to a tubular liquid distribution space to feed liquid to the heat transmission surfaces of the elements, and

Fig. 7 is the section VII-VII of the pipe and the distributive nozzle according to Fig. 6.

15 Evaporator 1 according to Fig. 1 comprises a cylindrical jacket 2 and parallel, bag-like heat transmission elements 3 made of plastic film and located inside the jacket. In the evaporator, elements 3 are tied into a pack that can consist of several dozens of elements. The evaporation by heat of the solution that is treated takes places on the outer surfaces 4 of the elements; in other words, in the gaps between the elements located against one another. Heat is obtained from the steam that is
20 simultaneously condensed inside the elements. The steam generated by the evaporation can be used as heating steam and it is circulated through a compressor to the supply channels of steam (not shown) leading inside the elements.

The upper end of each bag-like heat transmission element 3 comprises a lath 5 that is suitably cast from plastic, containing channels 6 for feeding the liquid to be
25 evaporated to the film surfaces between the elements to run downwards from above. By using vertical, winding joints 7, the interior of element 3 is divided into channels that direct the flow of the heating steam and the condensate generated by it towards a discoidal condensate eliminator 8 located at the lower end of the element and jointed inside the element. Bottoms 9 of adjacent elements 3 on both sides of
30 condensate eliminator 8 remain sufficiently apart from one another, so that they allow the precipitate, which was formed in the gaps between the elements in connection with the evaporation or other solid matter that came along with the

solution that was evaporated, to fall onto the bottom of the evaporator, where also solution 10 that did not evaporate accumulates.

As at each time of evaporation only a small portion of the solution to be evaporated is converted into steam, evaporator 1 comprises equipment that can be used to repeatedly recycle the solution that has not evaporated back to film surfaces 4 of the elements for re-evaporation. The equipment in question consists of recirculation line 11 that starts from the bottom of the evaporator, combined with line 12, which brings new solution to be evaporated in the evaporation process, pump 13, interior liquid distribution trough 14 of evaporator jacket 2, dam plate 15 that is located in the trough and works as an overflow threshold, and the supply channels 6 of liquid at the upper ends of the elements that we already mentioned. The purpose of the liquid distribution trough 14 is to provide as even a distribution of the solution fed to the evaporation as possible between channels 6 belonging to various elements 3. The solution is supplied onto the film surfaces 4 of the elements symmetrically from the liquid distribution troughs 14 on both sides of the elements, of which, however, only one is shown in detail in Fig. 1.

Fig. 2 illustrates best the structure of liquid distribution trough 14, which, according to the invention, also works as the separator of the precipitate or other solid matter that comes with the recycled solution. Trough 14 is provided with a number of parallel, slanting lamellas 16, which divide the trough into a lower and upper part 17, 18. According to the figure, inlet conduit 11 for the solution, which is downwards curved, joins with the lower part 17 of the trough, the bottom 19 of which slants towards exhaust piping 21 for the precipitate that starts from the opposite side to the mouth 20 of the circulation line of the trough. Parallel lamellas 16 are slanted towards the incoming direction of the solution so that, in accordance with the arrows in Fig. 2, the flow must wind more than 90° in order to get to flow channels 22 between the lamellas, which are directed obliquely upwards. In this condition, solid matter 23, which comes with the solution, can be separated from the stream flow partly under the effect of its own kinetic energy, i.e., centrifugal force, and partly under the effect of gravitational force, and allowed to sediment towards exhaust piping 21 that starts from the bottom of the trough. By adjusting the rate of flow, the process of flow can be kept, in a laminar and sufficiently slow state, in the lower part 17 of the trough, in the gaps between lamellas 16, so that lamellas 16, which work like clarifiers, ultimately prevent the solid matter from getting to the upper part 18 of the trough, at least not to an adverse extent. In the upper part of the trough, dam plate 15 converts the stream flow, which goes into supply channels 6,

into a turbulent form, further decreasing the risk of blocking in the narrow supply channels 6 that are divided into numerous branches (cf. Fig. 1).

In addition to the precipitate, liquid is removed from liquid distribution trough 14 into pipe 21; the amount of the liquid can vary within 3-50% of the flow coming to the trough through recirculation line 11. According to Fig. 1, the final separation of the precipitate from solid matter takes place in lamellate settling apparatus 24, from where the precipitate is removed into line 25 and the liquid is returned through line 26 to the suction face of circulation pump 13. From time to time, precipitate can be removed by rinsing with the valves of lines 21 and 26 being closed.

Figs. 3 and 4 show liquid distribution trough 14 of the evaporator, which differs from the one in Fig. 2 in that the trough has a flat bottom but it narrows in a V shape from mouth 20 of the recirculation line towards the opposite side of the trough, and that instead of slanting lamellas, the trough comprises intermediate bottom 27 comprising crooked pieces of pipe 28 that work as precipitate separators, allowing liquid to flow through. Gravitational force and the centrifugal force acting in the curved inlet conduit 11 press the precipitate towards the outer circumference of the curve and the bottom of trough 14, so that the majority of the precipitate drift directly to exhaust pipe 21 under the effect of its kinetic energy. The stream flow is directed to the said precipitate separators, where gravitational force separates the precipitate remaining in the flow, while the stream flow continues, through the lateral openings 29 at the upper ends of the separators, to the upper part 18 of liquid distribution trough 14. The flow rate in all pieces of pipe 28 is essentially the same because of the narrowing shape of trough 14.

In the application of liquid distribution trough 14 shown in Fig. 5, the crooked pieces of pipe 28 according to Fig. 3 are replaced with L-shaped projections 30 bordering the flow-through openings in intermediate bottom 27. Otherwise, the application in Fig. 5 corresponds to what is described above.

Figs. 6 and 7 show an application of the invention, where liquid distribution space 14 consists of a pipe with an essentially round cross-section, which is an extension of inlet conduit 11. According to Fig. 7, pipe 11 forms a curve, where centrifugal force presses the solid matter contained by the liquid to the outer circumference of the curve, and further to the bottom of liquid distribution space 14, from where the solid matter ends up in exhaust pipe 21. Parallel distributive nozzles 31 are attached to liquid distribution space 14, distributing the liquid, which is mainly purified of solid matter, to liquid channels 6 contained by end laths 5 of the parallel heat

transmission elements 3. Tips 32 of distributive nozzles 31 extending inside liquid distribution space 14 are bevelled to form an angle α , which is suitably about 10-35°, and the nozzles expand in a fan-like shape, so that each one of them feeds liquid to several adjacent elements 3. Furthermore, distributive nozzles 31 are
5 provided with inner baffle plates 33 to ensure an even distribution of liquid.

It is obvious to those skilled in the art that the various embodiments of the invention are not limited to the examples described above, but can vary within the following claims. Thus, the separation of precipitate according to the invention can be applied not only in the film evaporators described above but also in traditional evaporators
10 comprising metal heat transmission elements.

Claims

1. A method for evaporating a solution, comprising the spreading of the solution on the heat transmission surfaces (4) of the parallel, plate heat exchanger elements (3) of an evaporator (1) to run from the top downwards, the solution being fed from
5 a liquid distribution space (14) common to the elements, the solution (10) that remains on the heat transmission surfaces without evaporating and the precipitate that is formed in connection with evaporation are removed from the lower end of the evaporator, and the solution that has not evaporated is recycled back to the heat transmission surfaces for re-evaporation, **characterized** in that the solution to be
10 recycled is fed to the liquid distribution space (14) so that the precipitate (23) in the solution is separated in the space under the effect of its weight and/or its kinetic energy at the same time as the flow of the solution is directed upwards, that the precipitate is removed into an exhaust pipe (21) that begins from the bottom of the space, and that the solution is directed from the space to the supply units (6, 31) that
15 lead to the heat transmission surfaces (4) of the elements.
2. A method according to Claim 1, **characterized** in that the solution to be recycled is fed to the liquid distribution space (14) from the top downwards in the form of a flow (11) that curves towards the side or the end of the space.
3. A method according to Claim 1 or 2, **characterized** in that the solution to be
20 recycled is fed into a narrow, elongated liquid distribution space (14) from its one end, and that the precipitate is removed into an exhaust pipe (21) from the opposite end of the space.
4. A method according to any of the preceding Claims, **characterized** in that the solution to be recycled is fed underneath parallel lamellas (16) or an intermediate
25 bottom (27) provided with ports (28-30), which are located in the liquid distribution space (14), so that the flow of the solution winds towards the ports of the intermediate bottom or the flow channels (22) between the lamellas, and the precipitate (23) is separated from the flow under the effect of centrifugal force.
5. A method according to any of the preceding Claims, **characterized** in that the
30 precipitate is lead through an exhaust pipe (21) to a settling apparatus (25), where the precipitate is separated from the liquid phase that comes with it, after which the liquid phase is connected to the recirculation flow of the solution that takes place in the evaporator.

6. A method according to any of the preceding Claims, **characterized** in that the evaporator a film evaporator consisting of heat exchanger elements (3) made of flexible film material, such as plastic film.
7. An evaporator (1) comprising a jacket (2), parallel plate heat exchanger elements (3) fitted inside the jacket, the solution to be evaporated being arranged to run on the heat transmission surfaces (4) of the elements from the top downwards, a liquid distribution space (14), from where the solution to be evaporated can be spread, through supply units (6, 31), on the parallel heat transmission surfaces from their upper ends, members for removing the solution (10) that has not evaporated and the precipitate, which has generated in connection with evaporation, from the lower end of the evaporator, and a line (11) for recycling the solution that has not evaporated back to heat transmission surfaces of the elements for re-evaporation, **characterized** in that the liquid distribution space (14) also constitutes a separator of precipitate, where the recirculation line (11) feeds the solution into the space through its side or face, and the space is provided with an exhaust pipe (21) that starts from its bottom, so that the precipitate (23) in the recycled flow is separated in the liquid distribution space under the effect of its weight and/or kinetic energy, ending up in the exhaust pipe at the same time as the flow of recycled solution is directed upwards towards the supply units (6, 31) leading to the heat transmission surfaces (4) of the elements (3).
8. An evaporator according to Claim 7, **characterized** in being a film evaporator consisting of heat exchanger elements (3) made of flexible film material, such as plastic film.
9. An evaporator according to Claim 7 or 8, **characterized** in that the liquid distribution space (14) is located inside the evaporator jacket (2).
10. An evaporator according to any of Claims 7 to 9, **characterized** in that the recirculation line (11) is attached to one end of the elongated liquid distribution space (14), and that the exhaust pipe (21) for the precipitate starts from the opposite end of the liquid distribution space.
11. An evaporator according to any of Claims 7 to 10, **characterized** in that the recirculation line (11) is attached to the liquid distribution space (14) so that it curves from the top downwards.

12. An evaporator according to any of Claims 7 to 11, **characterized** in that the bottom of the liquid distribution space (14) is slanted downwards towards the exhaust pipe (21).
13. An evaporator according to any of Claims 7 to 12, **characterized** in that the liquid distribution space (14) converges in a sphenoid or conic form towards the exhaust pipe (21).
14. An evaporator according to any of Claims 7 to 13, **characterized** in that the supply units comprise distributive nozzles (31) that start from the liquid distribution space (14) and spread out like fans, each one of them feeding solution to several parallel gaps between the heat transmission surfaces (4) of the heat exchanger elements (3), evaporation taking place in the gaps.
15. An evaporator according to any of Claims 7 to 14, **characterized** in that the trough-like liquid distribution space (14) is provided with parallel, slanting lamellas (16), between which the solution is allowed to flow upwards.
16. An evaporator according to any of Claims 7 to 14, **characterized** in that the trough-like liquid distribution space (14) comprises an intermediate bottom (27) that divides it into a lower and upper part (17, 18), that the recirculation line (11) is attached, in the lateral direction, to the lower part (17) of the liquid distribution space, and that the intermediate bottom comprises ports, through which the solution is allowed to flow to the upper part (18) of the space at the same time as the precipitate (23) ends up in the exhaust pipe (21) that starts from the bottom of the space.
17. An evaporator according to Claim 16, **characterized** in that the flow routes formed by the openings in the intermediate bottom (27) are slanted upstream with regard to the incoming direction of the recirculation flow.
18. An evaporator according to any of Claims 15 to 17, **characterized** in that the trough-like liquid distribution space (14) is provided with a dam plate (15), over which the solution flows as an overflow to the supply units (6) of the parallel heat exchanger elements.
19. An evaporator according to any of Claims 7 to 18, **characterized** in that the exhaust pipe (21) leads to a settling apparatus (24), which separates the precipitate from the liquid phase that comes with it, and that the settling apparatus is

connected, by using a line (26), to the recirculation line (11) in order to join the separated liquid phase to the recirculation flow in the evaporator.

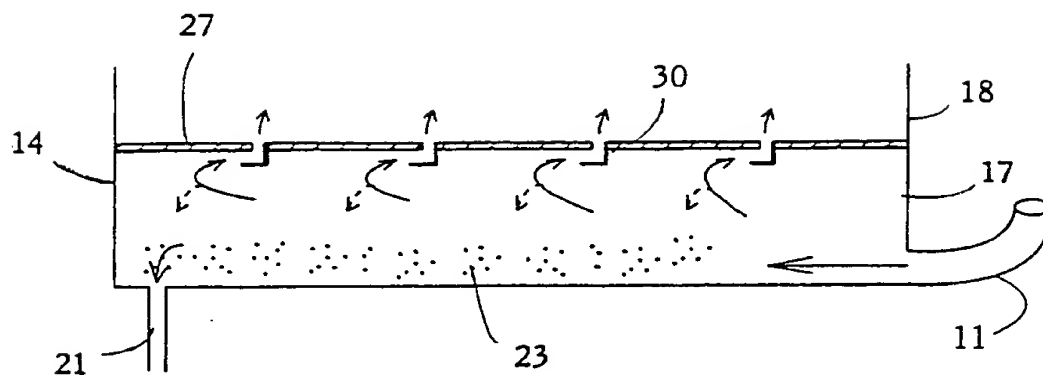


Fig. 5

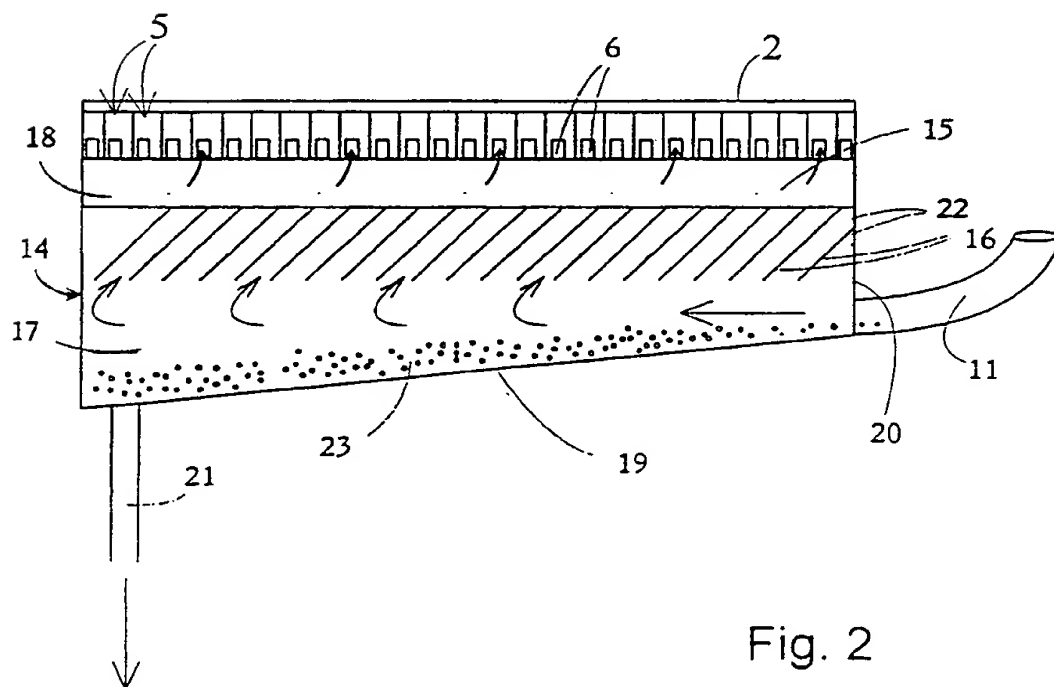


Fig. 2

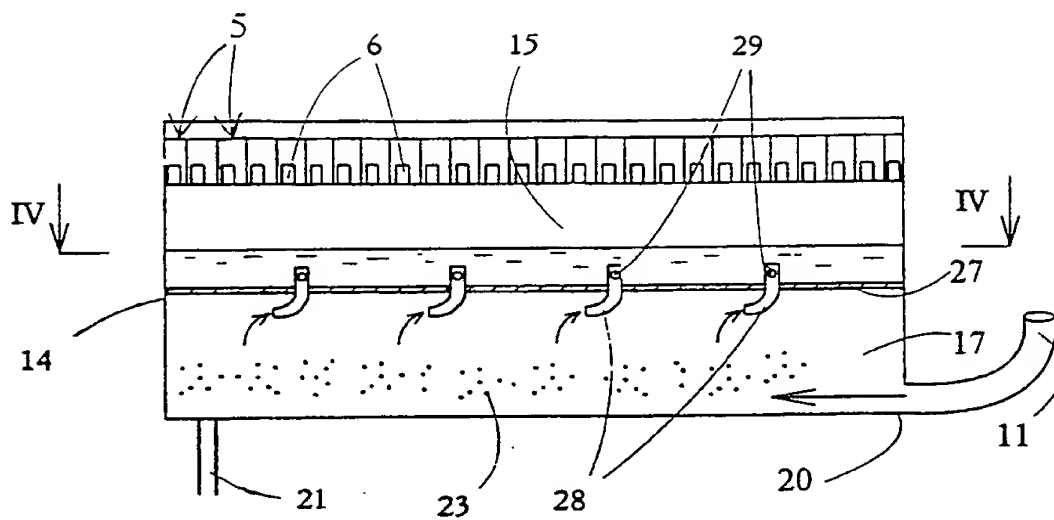


Fig. 3

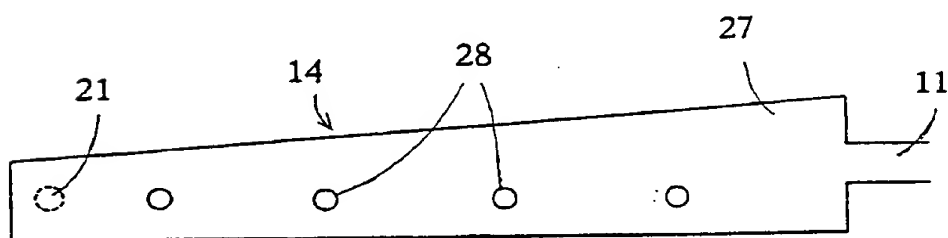


Fig. 4

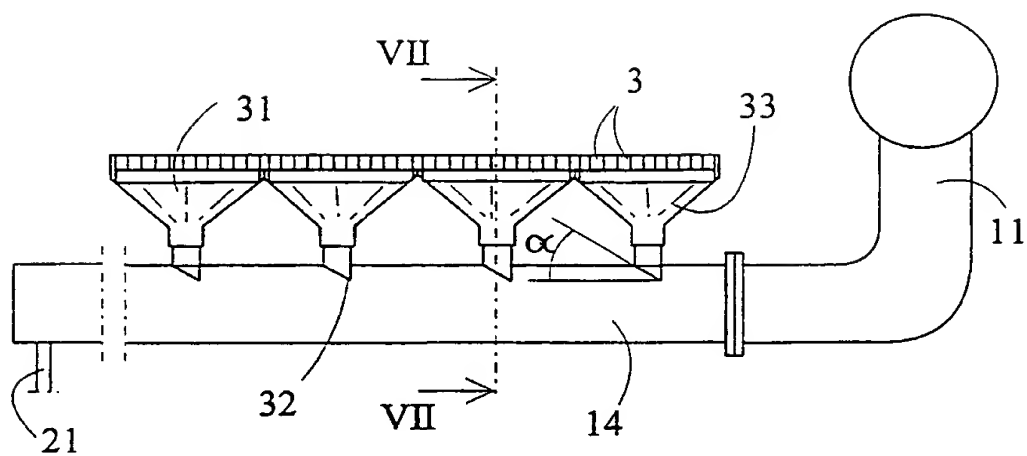


Fig. 6

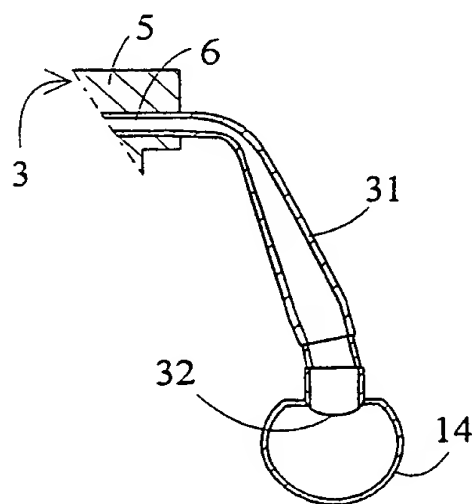


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 00/00278

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B01D 1/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

QUESTEL: EDOC, WPIL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3724522 A (JOHN T. POGSON), 3 April 1973 (03.04.73), column 2, line 46 - column 3, line 13; column 4, line 4 - line 23; column 4, line 38 - line 54, figures 1,2 --	1-19
A	WO 9508381 A1 (OY SHIPPAX LTD.), 30 March 1995 (30.03.95), page 1, line 12 - line 17; page 2, line 35 - page 3, line 9, claim 1 -- -----	1-19

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

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"E" earlier document but published on or after the international filing date

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

16 June 2000

Date of mailing of the international search report

24 -07- 2000

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INTERNATIONAL SEARCH REPORT

Information on patent family members

02/12/99

International application No.

PCT/FI 00/00278

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3724522 A	03/04/73	US 3738410 A	12/06/73
WO 9508381 A1	30/03/95	AU 7699494 A	10/04/95
		FI 94217 B,C	28/04/95
		FI 934143 D	00/00/00